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PLANNING IN LARGE PERSONNEL SYSTEMS: A REEXAMINATION OF THE TOPLINE STATIC PLANNING MODEL

Louis Miller, et al

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Louis Miller and Laura Critchlow Sammis

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10. ABSTRACT

Description of a model that provides a mechanism for testing the effects of a variety of policy variables on the structure of the USAF line officer force. The model produces counts of officers classified by component (AF Academy, Contract, Regular, Reserve), rating, grade, and year of service, and it also gives tables of "career flow", which show the flows into and out of each grade, by year, according to promotion, augmentation, and retirement. Input variables include yearly additions of academy graduates and contract officers, retention rates, parameters describing the promotion process, and totals of officers, regular officers, pilots, and navigators. This report describes the mathematical structure of the model and its inputs and outputs and also describes the Rand FORTRAN version.

11. KEY WORDS

TOPLINE
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PREFACE

The TOPLINE Static Flow Model, developed by Headquarters, USAF, in 1967, provides a mechanism for testing the effects of several policy variables on the structure of the line officer force and has played an important role in developing the USAF personnel plan for line officers.

In 1971, The Rand Corporation was asked by the Deputy Chief of Staff, Personnel, USAF, to review the original TOPLINE model. Since it was necessary to install a working version of TOPLINE at Rand, in support of the Officer Supply and Retention Project, the original computer model was rewritten. Our review resulted in two major changes to the model. First, at the time of rewriting the program, the mathematical methods employed were made more concise and computer-efficient. The "smear" technique, explained in Sec. II, was incorporated into the model. These changes in methods did nothing to affect the output. However, the second major change was the addition of considerable "career-flow" information in the output.

This report presents the modifications made to the original TOPLINE methodology and explains the rewritten computer program. The TOPLINE version reported here has been used by the Military Personnel Center, Randolph Air Force Base, as an aid in developing methods for studying officer flow systems, and its concepts have been used in the development of models used in the Defense Officer Management Systems.

SUMMARY

The TOPLINE* Static Flow Model, described in this report, produces counts of officers classified by component (Air Force Academy, contract, regular, reserve), rating, grade, and year of service, as well as tables of "career flow" that allow one to see the flows into and out of each grade by year resulting from promotion, augmentation, and retirement. The TOPLINE model assumes that the numbers of officers in each classification and the flows between classifications remain constant from year to year. Input variables include yearly inputs of academy graduates and contract officers, retention rates, parameters describing the promotion process, and totals of officers, regular officers, pilots, and navigators.

The Rand version presented here was derived from the Air Force's original; however, some modifications, such as changes in the mathematical techniques employed and the addition of the new section on "career flow," have been made.

This report describes the mathematical structure of the model with its inputs and outputs, and it also describes the Rand FORTRAN version

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*Total Officer Personnel Objective Structure for the Line Officer Force.

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I. INTRODUCTION

In recent years, the Air Force has been plagued by problems of less-than-optimal distribution of officers by years of service. These problems were caused, in part, by an overabundance of rated officers from previous war-time years and a failure to consider future needs in procurement, promotion, and assignment policies. Figure 1 illustrates this problem. It shows that:

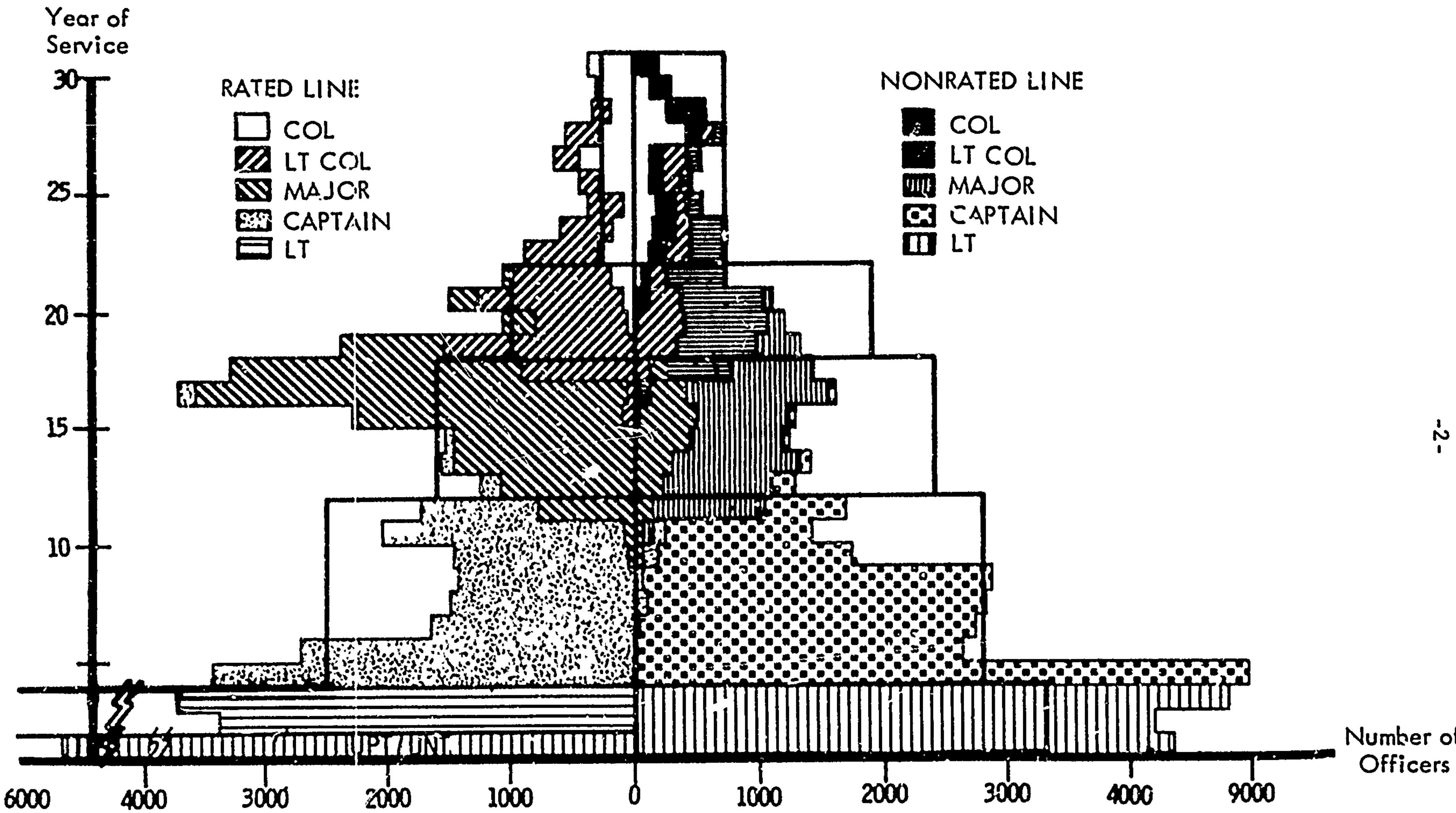
- Many nonrated officers with less than five years of service fill positions of higher-level, nonrated line positions.
- There is a shortage of rated officers with six to fourteen years of service.

As a result:

- Senior-rated line officers are used in cockpit, supervisory, and training positions that are normally filled by junior officers.
- Senior-rated line officers occupy top-level support positions, thereby blocking promotions of junior-nonrated line officers.
- Humps block promotions of groups coming behind the hump under high-retention conditions.

The heavy black lines on Fig. 1, which show grade authorizations--rated on the left and nonrated on the right--also show that these desired grade totals were far from being satisfied.

As a result of these problems, top Air Force managers decided, in 1967, that a systems approach to Air Force personnel management was needed and could be achieved by new computer capability. Accordingly, the Director of Personnel Plans formed an ad hoc planning group to develop personnel objectives that were to represent the Air Force position



SOURCE: Ref. 2.

Fig. 1—Air Force line officers: 30 June 1970

on vital personnel issues. These objectives have been published as Vol. I, *The USAF Personnel Plan.*(1) Other volumes of this study translate the qualitative concepts of Vol. I into quantitative terms for officer, airman, civilian, and reserve forces.

In TOPLINE,* key classification factors or attributes such as component, grade, aeronautical rating, and year of service are used to group officers into cells or "states" within the force structure. Two computer models were designed to study the structure and flows among states that result from policy changes. These changes affect such events as promotion, augmentation into the Regular Air Force, and selection into the career reserves, and also the size of the force, etc.

The first model, the static personnel planning model, is a steady-state model used to study long-range personnel objectives. A static model assumes that equilibrium conditions apply; i.e., loss rates and other planning factors are stable and do not change from year to year, and the additions to a state always equal the losses from a state so that the number in the state remains unchanged from year to year. The officer structure computed by the static personnel planning model is called the steady-state or long-term-objective officer structure or force.

In addition to its usefulness as a tool in designing long-term objectives for the line officer structure, the static model can also test the effects of changes in various policy variables and give policy planners an idea of the overall long-term effects of personnel policies. As a result, although the static nature of the model keeps it from faithfully imitating real life, it can be very useful as a means of evaluating a personnel policy or proposed changes in such a policy.

The other model, the dynamic personnel planning model, counts the officers currently in each state and then applies policies and planning factors each year that promote, augment, and select career reserve officers, and age the force year by year, allowing for new accessions and graduates of undergraduate pilot or navigator training (UPT or UNT) courses. This is done for several consecutive years and results are

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*Total Officer Personnel Objective Structure for the Line Officer Force.

printed for each year. The dynamic model is not discussed further in this report; all comments that follow apply to the static personnel planning model only.

In 1971, The Rand Corporation was asked to review the model. Partly as a result of this review, but mainly because it was desirable to have a working version of the model at Rand, the TOPLINE Static Flow Model was rewritten. The new version was more concise mathematically than the earlier version, but perhaps the most important change in methodology involved development of the "smear technique" for showing distribution of men over years of service. This technique is simple, accurate, and efficient, and it helped simplify the model. The changes in mathematical methods did nothing to affect the results of the computations or the model's outputs; changes in output occurred later, when Rand added career-flow methodology and the corresponding tables of output.

Section II of this report describes the algorithms used for computing the various outputs. First, the smear technique is discussed; next, personnel are distributed across grades, taking into account such factors as force-outs and promotions. After the men have been distributed, we discuss the process of classifying them by category and rating. Finally, there is a discussion of the career-flow tables.

Section III discusses the model inputs and outputs. Inputs include retention rates for various categories of officers, promotion policy factors, force-out years, and yearly training rates. Output consists of counts of officers classified by category,* rating, grade, and year of service. Further output is the career-flow tables, each with its own table showing percentage relationships between steady-state numbers of officers and retirement and promotion flows.

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*Under "category" we have four subsections: Air Force Academy graduate, contract, regular (other than Air Force Academy graduate), and reserve. "Contract" as used in TOPLINE is applied to any non-regular officer retained beyond his initial commitment. Since short-time contracts (3 to 5 years) have not been authorized by Congress for line officers, the term "contract" officers as used in this report is synonymous with "career reserve" officers. "Reserve" officers in this report are reserve officers serving in their initial commitment period.

The last section, Sec. IV, briefly discusses the application of such a model as TOPLINE and its usefulness as a tool in personnel policy planning.

Three appendixes follow the body of the report: Appendix A presents a sample of the model's output; Appendix B is a very short flow chart giving an overview of the model; then, mainly of interest to programmers, Appendix C discusses programming considerations.

II. DESCRIPTION OF THE MODEL

The description of the model is arranged in four parts. First, we examine the nature of the relationship between retention data, total number of officers, and the distribution of these officers over years of service. Next we describe the promotion and grade structure component. Then, we consider classification by category and rating. The fourth part of the discussion concerns the career-flow tables, which were not part of the original TOPLINE model.

Stated differently, we begin by building a simple model that considers the total number of officers and retention rates and then determines how the officers are distributed over years of service. We next expand the model to include promotions and grade structure. Then we consider classification by category and rating, and finally we discuss career flow.

This order of presentation was chosen to facilitate the exposition, but to avoid confusion, it is perhaps best to think of the computation within the actual program as being organized around the third discussion part, classification, and proceeding as indicated by the "stages" of that discussion. The material on year of service is presented first because it is used repeatedly in the computations and is important to understanding the subsection on classification. The second part of the discussion, grades and promotion logic, affects the year-of-service scheme by modifications of retention rates. It is important to realize that the dimension of grades is independent of the other dimensions. According to this model, the probability that a randomly chosen man is in a particular grade depends only on his year of service and not on his category or rating.

THE SMEAR TECHNIQUE FOR DETERMINING YEAR OF SERVICE

Consider a much simplified, highly aggregated model in which no distinction is made between categories, ratings, or grades and year of service is the only dimension. Let the total number of officers be given as a number, M. The only problem is to determine how M men are

distributed over the years of service, 1 through 35. We are particularly interested in the number in the first year, since this is the number that enter the force each year. The model requires a set of "retention rates," r_j, $(j = 1,2,\ldots,35)$, with $r_1 = 1$ and the rest in between 0 and 1 (inclusive). A retention rate is the proportion of men in year of service $j - 1$ that are in the system the next year. If there are N_{j-1} men in year $j - 1$, the number in year j will be

$$N_j = r_j N_{j-1} .$$

A slightly different interpretation is to regard the N's as expected values and the retention rates as conditional probabilities describing the behavior of an individual. Define E_j as the following event: An individual is in the system for the j*th* year, or equivalently, he does not retire before his $(j - 1)$*th* anniversary. Then a retention rate can be defined as

$$r_j = \text{Prob}(E_j | E_{j-1}) .$$

If two successive retention rates are multiplied together, we have

$$\begin{aligned} r_{j+1} r_j &= \text{Prob}(E_{j+1} | E_j)\ \text{Prob}(E_j | E_{j-1}) \\ &= \text{Prob}(E_{j+1}, E_j | E_{j-1}) \\ &= \text{Prob}(E_{j+1} | E_{j-1}) . \end{aligned}$$

The first result follows from the definition of conditional probability: $P(A|B)\ P(B) = P(A,B)$. The second step is true because the event E_{j+1} includes the event E_j; a man who stays at least 10 years also stays at least 9 years. By the same argument, we continue multiplying retention rates together to get

$$\prod_{j=a}^{j=b} r_j = \text{Prob}(E_b | E_{a-1}) .$$

If a is taken to be 2 (or 1, since $r_1 = 1$), the conditioning is removed and we have

$$c_b = \prod_{j=1}^{j=b} r_j = \text{Prob}(E_b) .$$

These are called "survival rates."

The complement of E_j is the following event which has probability (1 - c): A man leaves before his *jth* year. Let L be the career length. Then, the distribution function of career length is $F_L(\ell) = P(L \leq \ell) = 1 - c_\ell$. It is easily shown (through summation by parts) that if L is a random variable having distribution function $F_L(\ell)$, then the mean is given by

$$E(L) = \sum_\ell (1 - F_L(\ell)) = \sum_\ell c_\ell = C .$$

The implication is that if the c_ℓ's are summed, we have the mean career length. Denote the sum by C (for mean career).

At this point, we know the total number of officers, M, and the mean length of career, C. The solution to our problem (distributing the M men over the years of service) comes from the "flow equation" in queueing theory that says

mean number of men in the system
= (arrival rate) × (mean time in the system).*

In our notation this is $M = N_1C$, since the number of men in the first year is the arrival rate of new officers. Solving for N_1, we have

$$N_1 = \frac{M}{C} .$$

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*An outline of the proof may be found in Ref. 3, Appendix B, p. 136; the complete proof is given in Ref. 4.

Determining the rest of the N_j's is easy, since

$$N_j = r_j N_{j-1} = r_j r_{j-1} N_{j-2} = r_j \cdots r_2 N_1 = c_j N_1 \ ,$$

or

$$N_j = c_j \ \frac{M}{C} \ ;$$

We call the process of computing a sequence of N_j's "smearing," i.e., we smear the M men over the possible years of service.

GRADES AND PROMOTION LOGIC

Let us expand our simple model by introducing a grade structure. The TOPLINE model distinguishes among four grades that we will label as 3, 4, 5, and 6. Grade 3 contains captains and personnel of lesser rank; grade 6 contains full colonels and ranks above. The notion of grades is introduced by computing a 35 × 4 matrix X^* having all entries between 0 and 1. The rows correspond to years and the columns to grades. An entry, X_{jg}, is the fraction of those in year j that have grade g. Each row is a probability distribution and sums to 1. Once it has been determined that the total number of men in year j is N_j, the number of lieutenants and/or captains in that year is $X_{j3}N_j$, there are $X_{j4}N_j$ majors, and so on.

Consider an oversimplified model wherein all promotions to a given grade happen in a single year, nobody is ever forced out for failure to be promoted, and there is no interaction between the promotion and retirement process. First, we have to identify the years in which the promotions take place. Let them be years 11, 17, and 21. That means that all majors spend year 11 in the grade of major and were captains in their tenth years.

The model uses a set of "promotion opportunity" numbers, which specifies the fraction of people in a grade at a promotion point that get promoted. To be more specific, suppose that in year 11 there are

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*In the FORTRAN program, the distribution array is called DIST rather than X and the subscripts referring to grade levels are 1, 2, 3, and 4 rather than 3, 4, 5, and 6.

n_3 men in grade 3 and n_4 men in grade 4. The promotion opportunity specifies the value of $n_4/(n_3 + n_4)$. As an example, let the opportunity for promotion to major be 0.9; to lieutenant colonel 0.75, and to colonel 0.4. In tabular form, the data are:

From Grade	To Grade	At Year	Promotion Opportunity
3	4	11	0.9
4	5	17	0.75
5	6	21	0.4

The X array is computed as diagrammed in Fig. 2. Through year 10 everyone is in grade 3, and $X_{j3} = 1$ for $j = 1,2,\ldots,10$. At year 11, 90 percent of the men (present in year 11) become majors, and 10 percent are left behind as lieutenants and/or captains forever. At year 17, the 90 percent who became majors are split--75 percent of them are promoted to lieutenant colonel and 25 percent remain behind. At this point, 22.5 percent are majors (i.e., 25 percent of 90 percent), and 67.5 percent are lieutenant colonels. At year 21, the 67.5 percent that became lieutenant colonels are again split--40 percent are promoted to colonel or general and 60 percent remain behind.

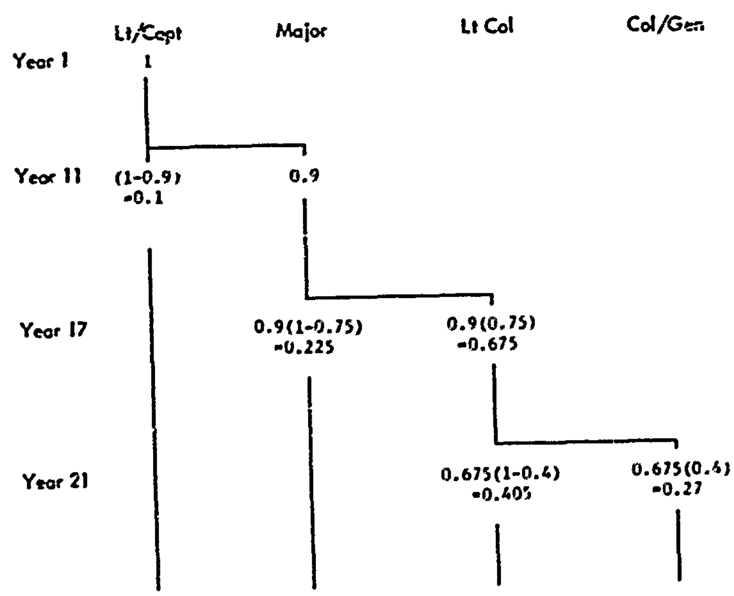


Fig. 2 — Computation of distribution of grades by year for simplified promotion model

The next level of complication is to assume that promotions take place over four-year periods. Now it is necessary to give four opportunity fractions for each type of promotion. For example, we might have the following:

Grade From	Grade To	At Year	Promotion Opportunity
3	4	9	0.01
		10	0.05
		11	0.8
		12	0.9
4	5	15	0.02
		16	0.06
		17	0.65
		18	0.75
5	6	19	0.02
		20	0.04
		21	0.25
		22	0.4

The computations are done in a similar manner except that four "splits" have to be computed for each type of promotion. It may help to display the nature of the computations in terms of formulas. To do this, define the following notation.

Let I_g be the first year of the promotion zone to grade g. Thus, in our example, $I_4 = 9$, $I_5 = 15$, and $I_6 = 19$. Define a "generalized" set of promotion opportunity numbers as follows.

Let 0_{jg} be the proportion of those men in year j who have achieved grade g - 1 that are in grade g or higher. For an individual officer, a probabilistic interpretation would be

$$0_{jg} = \text{Prob}\ \{\text{Grade} \geq g \,|\, \text{Grade} \geq g - 1 \text{ and YOS} = j\} .$$

As an example, from our data we see that $0_{17,5} = 0.65$. So if we look at men in year 17, of all whose grade is major (4) or higher, 65 percent will be lieutenant colonels (5) or higher. Note that promotion opportunities are cumulative; for fixed g, they are nondecreasing

functions of j. This definition is generalized in that it makes sense for year and grade combinations other than the twelve values in the table above. The extension to other combinations is made by defining

$$0_{jg} = 0 \qquad \text{for } j < I_g$$

$$0_{jg} = 0_{I_g + 3, g} \qquad \text{for } j \geq I_g + 3 \ .$$

The first line says that nobody can be in grade g prior to year I_g; that is, for g = 5, there are no lieutenant colonels before year 15. The second line says that in years beyond the end of the promotion zone, the division between men in grade g - 1 and grades g and above remains constant.

Table 1 gives the generalized promotion opportunity numbers. The data go one step beyond this point of the explanation in that the numbers in each column remain constant beyond the ends of the promotion zones up to points where they change to 1.0. This results from promotion failure force-outs and is explained subsequently.

With these definitions, the X array can be computed by the following formulas, which hold for j = 1,2,...,35.

$$X_{j3} = (1 - 0_{j4})$$

$$X_{j4} = 0_{j4}\,(1 - 0_{j5}) \quad = (1 - X_{j3})\,(1 - 0_{j5})$$

$$X_{j5} = 0_{j4}0_{j5}\,(1 - 0_{j6}) = (1 - X_{j3} - X_{j4})\,(1 - 0_{j6})$$

$$X_{j6} = 0_{j4}0_{j5}0_{j6} \quad = (1 - X_{j3} - X_{j4} - X_{j5}) \ .$$

The two sets of formulas on the right-hand side are equivalent because

$$\sum_{k=3}^{g-1} X_{jk} + \prod_{i=4}^{g} 0_{ji} = 1 \text{ for } g = 4,5,6 \ .$$

Table 1

GENERALIZED PROMOTION OPPORTUNITIES

	To Grade		
Year	Major (4)	Lt Col (5)	Col/Gen (6)
1	0	0	0
.	.		
.	.		
.	.		
8	0		
I_4 9	0.01	.	.
10	0.05	.	.
11	0.80	.	.
12	0.90		
13	0.90		
14	0.90	0	
I_5 15	0.90	0.02	
Y_3 16	1.00	0.06	
17		0.65	
18		0.75	0
I_6 19		0.75	0.02
20		0.75	0.04
21		0.75	0.25
22		0.75	0.40
Y_4 23		1.00	0.40
24			0.40
25			0.40
26			0.40
27			0.40
28			0.40
Y_5 29	.	.	1.00
30	.	.	
.			.
.			.
.			.
35	1.00	1.00	1.00

The sum above is the fraction of men in year j that have not been promoted to grade g, and the product is the fraction of men that have been promoted at least to grade g. Together, these account for everybody, and the two terms must sum to 1. The Rand FORTRAN program uses the second set of formulas because of the way in which above-the-zone promotions are handled.

Fourth-Year Promotion Opportunities

In designing the model, the promotion opportunities for the fourth year of each promotion zone were intended to specify a fraction of the number of officers coming into the third year rather than into the fourth. For example, the number of majors in year 12 is supposed to be $0.9N_{11}$ instead of $0.9N_{12}$. Since $N_{11} = N_{12}/r_{12}$, instead of using 0.9 as the opportunity number, the program uses $0.9/r_{12}$. The catch is that there are actually ten different retention arrays. We have four officer categories and three ratings. For each combination of category and rating we have a different retention array (there are ten rather than twelve arrays because two of the category-rating combinations have the same retentions as two other such combinations--see pp. 18 and 19 for further clarification). At this point, however, we have not classified men according to category and rating, so the program does not know which retention numbers to use to adjust for fourth-year promotions. To compute the adjustments we supply the program with generalized retention coefficients for each of the three fourth-year-of-promotion-zone years and it uses these to adjust the fourth-year promotion opportunities.

Promotion Failure Force-Outs

The next complication occurs because officers who are not promoted must retire by a specified year, depending on their grade. Since the model deals with three levels of promotion, there are three force-out years defined as follows.

Let Y_g be the first year in which there are to be no men in grade g, for g = 3, 4, and 5. If the last year of service for captains is 15, for majors, 22, and lieutenant colonels 28, we should set $Y_3 = 16$, $Y_4 = 23$, and $Y_5 = 29$.

Two modifications have to be made to represent force-outs: First, the retention rates must be adjusted to make forced out officers disappear, and, second, the grade distribution, X, must be modified to reflect that one grade drops out at each force-out year.

Tackling the latter problem first, at year Y_g everyone present must have a grade of at least g + 1. This is accomplished simply by setting, for g = 4, 5, 6,

$$0_{jg} = 1 \text{ for } j > Y_{g-1} \;.$$

For example, if the captain force-out year is 15, $0_{j4} = 1$ for years 16 and up. It follows from the relationship between X_{j3} and 0_{j4} that X_{j3} is zero for those years.

Note that from the formulas for the X array and the definition of generalized promotion opportunity numbers, it can easily be shown that the proportion of men in a grade in the year prior to that grade's force-out year is one minus the promotion opportunity in the fourth year of the promotion zone. For our example,

$$X_{15,3} = (1 - 0_{12,4}),\ X_{22,4} = (1 - 0_{18,5}), \text{ and } X_{28,5} = (1 - 0_{22,6}) \;.$$

The designers of the model wisely chose not to make the user responsible for adjusting retention rates because the adjustment is a function, in part, of the force-out years and promotion opportunities. The retention rates supplied by the user do not reflect force-outs; the program does the work instead.

To avoid confusing subscripts, consider the adjustment necessary for grade 3 force-outs at year 16. The number of officers in year 15 is N_{15}, of which $X_{15,3}N_{15}$ are in grade 3 and $0_{15,4}N_{15}$ are in higher grades. In the next year, the numbers become $r_{16}X_{15,3}N_{15}$ in grade 3 and $r_{16}0_{15,4}N_{15}$ in higher grades. But the first group is lost, leaving only the second. Therefore, we should use $r_{16}0_{15,4}$ as the retention rate. The same reasoning holds for the other two force-out years. Remembering that this opportunity rate is the same as the opportunity rate in the fourth year of the promotion zone, the rule is: Multiply

the retention rate in each force-out year by the fourth-year promotion opportunity for promotions out of the grade being forced out. Or, equivalently, use the multiplier: one minus the proportion of men in the forced-out grade in the year prior to the force-out year.

The left-hand portion of Table 2 shows the X array computed with the data given so far. (There is no correction to the fourth-year promotion opportunities.)

Fudge Factor

The next complication of the grade and promotion logic has two possible real-world interpretations, which are represented mathematically in exactly the same way for grade distributions. The difference between the two interpretations shows up later, in the career-flow tables. The user of the FORTRAN version may specify which interpretation he wishes to see.

What we wish to represent with the first interpretation is the effect that being promoted has on retention rates. The assumption is that if a man is constantly passed up for promotion, he is more likely to retire than those men who are promoted. For example, a captain who reaches his thirteen year of service without being promoted to major (twelfth year of service is the last year that he can be promoted) no longer has any chance of being promoted and so is more likely to retire than a major in the thirteenth year of service.

For grades 3, 4, and 5 we have a number used to modify the X array. This number, f, is assumed to have the value 0.01 (f is the "fudge factor"). Refer back to the right-hand set of formulas for computing X (those where X_{j4} is based on X_{j3}, etc.). We compute X as given by the formulas on p. 12, except for the years between the first year after the promotion zone and the last year before force-out. For grade 3 these would be years 13, 14, and 15. For year 13, take $X_{13,3}$ as computed by the formula and subtract f. In year 14, subtract 2f, and in year 15, subtract 3f. The new values of $X_{13,3}$, $X_{14,3}$, and $X_{15,3}$ are subsequently used in the remaining formulas. When g = 4, the same type of modifications are made to the computations of $X_{19,4},\ldots,X_{22,4}$. Similarly, the same is done when g = 5.

Table 2

GRADE DISTRIBUTIONS BY YEAR

	Without Above-the-Zone Promotions				With Above-the-Zone Promotions			
Year	Lt/Capt	Major	Lt Col	Col/Gen	Lt/Capt	Major	Lt Col	Col/Gen
1	1.0				1.0			
2	1.0				1.0			
3	1.0				1.0			
4	1.0				1.0			
5	1.0				1.0			
6	1.0				1.0			
7	1.0				1.0			
8	1.0				1.0			
9	0.99	0.010			0.99	0.0100		
10	0.95	0.050			0.95	0.0500		
11	0.20	0.800			0.20	0.8000		
12	0.10	0.900			0.10	0.9000		
13	0.10	0.900			0.90	0.9100		
14	0.10	0.900			0.08	0.9200		
15	0.10	0.832	0.0180		0.07	0.9114	0.0186	
16		0.940	0.0600			0.9400	0.0600	
17		0.350	0.6500			0.3500	0.6500	
18		0.250	0.7500			0.2500	0.7500	
19		0.250	0.7350	0.0150		0.2400	0.7448	0.0152
20		0.250	0.7200	0.0300		0.2300	0.7392	0.0308
21		0.250	0.5625	0.1875		0.2200	0.5850	0.1950
22		0.250	0.4500	0.3000		0.2100	0.4740	0.3160
23			0.6000	0.4000			0.5900	0.4100
24			0.6000	0.4000			0.5800	0.4200
25			0.6000	0.4000			0.5800	0.4300
26			0.6000	0.4000			0.5600	0.4400
27			0.6000	0.4000			0.5500	0.4500
28			0.6000	0.4000			0.5400	0.4600
29				1.0				1.0
30				1.0				1.0
31				1.0				1.0
32				1.0				1.0
33				1.0				1.0
34				1.0				1.0
35				1.0				1.0

The general idea is that by progressively reducing the proportion of men in the lower grades, we are putting more people in higher grades. Since our retention rates are given by year of service and component, but *not* by grade, we do this to reflect the fact that in a given year of service more men are lost from lower grades through retirement than from higher ones.

This reduces the number of men forced out (since some have retired before force-out), so the force-out adjustment to retention rates remains as before, only now it is necessary to use $(1 - X_{y-1,g})$ as the adjustment factor for r_{y_g} instead of the promotion opportunity fraction

The X array, with the fudge factor taken to be 0.01, is shown on the right-hand side of Table 2.

The second interpretation of this adjustment would be that we are including above-the-zone promotions in our model. In this case, f would be the proportion of men who are promoted above the zone. Rather than thinking of losing a certain number of men from a lower grade and retaining an equal number in the next higher grade, we would just be moving the same men from one grade to the next by promoting them.

The results of these two interpretations are exactly the same until we compute the career-flow tables which will be discussed later.

Variable Promotion

The final complication incorporated in the FORTRAN computer model allows for a promotion policy in which promotion opportunities may vary from pilots to navigators to nonrated--it is not necessary to have equal promotion opportunities across ratings.

In the model we compute three X arrays--one for each rating--using the appropriate promotion opportunities in each case. Then, when we use the X arrays to distribute the men across grades, we distribute each rating separately with the correct X array. To get a table showing the number of men in each grade by year for the entire force (for all ratings), we merely add the other three tables together.

CLASSIFICATION OF OFFICERS BY CATEGORY AND RATING

Thus far, we have constructed a model that takes into consideration

years of service and the officer grade and promotion structure. We are now ready to add classification by category and rating to our model.

The four officer categories are Air Force Academy graduates (AFA), contract (cont),* regular (reg), and reserve (res). These categories are exclusive; AFA and regular are distinct. For computational purposes, a fifth category called "other" is defined, which is simply a lumping together of regular and reserve.

On the second dimension, rating, we have pilots (P), navigators (N), and nonrated (NR).

Apart from how we choose to present the results, the problem is to calculate how many men are in each of the twelve classes (four categories multiplied by three ratings).

Each class has its own set of retention rates, except that no distinction is made between regular and reserve pilots or between regular and reserve navigators. (Thus, the category "other" makes sense.) As described earlier, from the retention rates we can compute survival rates and, by summing, determine the mean career lengths, which we denoted by C (see p. 8). In the earlier discussion we used N_1 to indicate the number of officers in the first year. But in the case of contract and regular categories, officers do not enter in the first year. Therefore we use T to denote the number of men entering a class, either in year 1 or at the end of the initial obligation, whichever applies. Our flow equation becomes

$$M = T \times C ,$$

where M is the total number in the class.

In dealing with any class, we are given either T or M. With T we can compute M from the flow equation and also distribute men over the years from the equations

*TOPLINE distinguishes between non-career reserve and career reserve officers as follows: non-career reserve officers (those reserve officers who leave the service before the end of their commitment or at the end of their commitment) are known as "reserves"; career reserve officers (those who stay on after the end of their commitment) are known as "contract" officers.

$$N_j = T \times c_j \ .$$

With M, which we get with a little arithmetic, we can solve the flow equation for T and proceed to make the distribution. Therefore, our main concern is computing T's and M's.

Inputs

Input data for the model include the following:

M = Total number of officers

$M_{AFA} + M_{reg}$ = Total number of officers with regular commissions

M_P = Total number of pilots

M_N = Total number of navigators

$T_{AFA,P}$ = Total number of first-year AFA pilots

$T_{AFA,N}$ = Total number of first-year AFA navigators

$T_{AFA,NR}$ = Total number of first-year AFA nonrated

$T_{cont,P}$ = Total number of contract pilots in first year after initial obligation

$T_{cont,N}$ = Total number of contract navigators in first year after initial obligation

$T_{cont,NR}$ = Total number of contract nonrated in first year after initial obligation

Starting with these data, the computation proceeds in five stages.

Stage 1: AFA and Contract. Since the six T's are given, we can solve immediately for the M's associated with the three ratings in each of the two categories. We now have $M_{AFA,P}$, $M_{AFA,N}$, $M_{AFA,NR}$, $M_{cont,P}$, $M_{cont,P}$, and $M_{cont,NR}$.

Stage 2: Other* Pilots and Navigators. Now we can compute

$$M_{other,P} = M_P - M_{AFA,P} - M_{cont,P}$$

*Recall that "other" includes regular and reserve.

and

$$M_{other,N} = M_N - M_{AFA,N} - M_{cont,N} .$$

These lead us to the related T's by means of the flow equation.

Stage 3: Categorizing Other Pilots and Navigators into Reserve and Regular. Precisely the same computation is carried out for pilots and navigators. Lengths of initial commitments for pilots and navigators (also nonrated) are given as data. Let K_p be the final year of the initial commitment for pilots. We begin with the assumption that all other pilots are reserve through year K_p and are regular thereafter. Thus, we set

$$N_{res,P,j} = N_{other,P,j} \qquad \text{for } j \le K_p$$

$$N_{reg,P,j} = N_{other,P,j} \qquad \text{for } j > K_p .$$

From here it is assumed that people taking regular commissions actually sign up earlier than the end of their commitments so that the following adjustments are made:

$$N_{reg,P,K_p} = N_{reg,P,K_p+1} ,$$

which says that all regular pilots in the year after the end of the initial commitment were also regular in the final year of the commitment. It is also assumed that 91.2 percent of these people were regular in the year before, or

$$N_{reg,P,K_p-1} = 0.912\ N_{reg,P,K_p} ,$$

and that 44.5 percent of those people were regular in the year before that, or

$$N_{reg,P,K_{p-2}} = 0.445\ N_{reg,P,K_p-1} .$$

To maintain the same number of pilots, the counts of reserve pilots in the three years are adjusted so that

$$N_{res,P,j} + N_{reg,P,j} = N_{other,P,j} \ .$$

Statistics on other navigators are handled in exactly the same way, and the same adjustment fractions are used.

All that remains is to calculate the numbers of other regular and reserve nonrated officers. Before going on to that, we point out a detail that has been neglected for the sake of simplicity: first-year pilots and navigators are considered as nonrated. This means that the distribution process for AFA and other rated officers begins with year 2 rather than year 1, and the first-year men are included with the nonrated group.

Stage 4: Regular, Nonrated. It is assumed that the desired total number of officers with regular commissions will be met, and this number is given as $M_{AFA} + M_{reg}$. We know the number of AFA graduates and the numbers of regular pilots and navigators in the system, so we can compute

$$M_{reg,NR} = (M_{AFA} + M_{reg}) - (M_{AFA,P} + M_{AFA,N} + M_{AFA,NR})$$

$$- (M_{reg,P} + M_{reg,N}) \ .$$

For this computation, the first-year pilots and navigators who are considered nonrated are included in the pilot and navigator counts on the right-hand side of the equation so that they are not part of the total we seek.

In this case, the smearing process is a little more involved than usual. We want to distribute this number of people over the years $K_{NR} + 1$ through 35, but we also want the number present in year K_{NR} to be the same as in the year $K_{NR} + 1$ and half that number to be present in year $K_{NR} - 1$. Yet the total sum is constrained to be what was computed above.

First of all, the survival rates must be computed as though the retention rates are all 1 in the years $1,2,\ldots,K_{NR} + 1$ because as far

as the smearing process is concerned, they all enter in year $K_{NR} + 1$.* The effect of adjusting for the last two years of the initial commitment is that the average career length is 1.5 years longer than that obtained by summing (modified) continuation rates increasing from K_{NR+1}. The increased value of C produces a smaller value of T, so that after smearing and adjusting, our result is the desired total, $M_{reg,NR}$.

The computation goes as follows: Compute the survival rates as though the retention rates were all 1 through year $K_{NR} + 1$. Sum these from year $K_{NR} + 1$ through 35 to get C, the average career length beyond the initial commitment. Let T be the number of men in year $K_{NR} + 1$. Using this number as a basis, we want to distribute over these years and have the sum be 1.5T less than $M_{reg,NR}$. Suppressing the subscripts on M, this means that T must satisfy

$$T = \frac{M - 1.5\,T}{C}$$

or

$$T = \frac{M}{C + 1.5}\ .$$

Now the distribution can be done, and the number of men in year K_{NR} is set equal to T and the number in the year before is set to T/2.

Stage 5: Reserve, Nonrated. At this point everyone has been accounted for except the reserve nonrated officers. Therefore, we may compute:

$$\begin{aligned} M_{res,NR} = M &- (M_{AFA,P} + M_{AFA,N} + M_{AFA,NR}) \\ &- (M_{cont,P} + M_{cont,N} + M_{cont,NR}) \\ &- (M_{other,P} + M_{other,N}) \\ &- M_{reg,NR}\ . \end{aligned}$$

---

*This might have been treated as an input data convention, but instead, the program makes the adjustment. However, the program only makes the adjustment through the year K_{NR} so that the user must be certain that the retention rate is 1 in year $K_{NR} + 1$.

Again, we assume first-year pilots and navigators have been counted as rated so that $M_{res,NR}$ does not include the first-year other pilots and navigators who are, in reality, nonrated.

It is assumed that these people are present only until the end of their initial commitments, so this number must be distributed over years $1,2,\ldots,K_{NR}$. However, for reserve, nonrated it is *incorrect* to smear the number computed above. Instead, add to $M_{res,NR}$ the total number of reg,NR officers in years $K_{NR} - 1$ and K_{NR}, smear this sum, and then remove these extra men.

Together, the last two classes, reg,NR and res,NR, make up a class that we could call other,NR. Treatment of this class is more complex than that of the rated classes because each rated class has to satisfy only one constraint--that on the total number of pilots or navigators. The division between regular and reserve was not constrained but was determined the same way regular commissions are given. With nonrated men, we may still give some reserves regular commissions, but there are *two* constraints: Both the number of regulars and the number of reserves are given, not just the sum.

CAREER FLOW

The last part of the output of TOPLINE is an extension of the original Air Force model. The new output consists of 112 career-flow tables, each with a matching table of percentages.

These tables are divided up three ways: First there are four sets of 28 tables each, one set per rating (pilots, navigators, nonrated) and one set for all ratings combined. Second, each set is divided up into four subsets of 7 tables each, one subset for each of the four grade levels. The 7 tables in each subset are for seven sources of commission (AFA regular, other regular, total regular, reserve, contract, total reserve, and total regular plus total reserve). Total reserve means reserve plus contract; i.e., non-career reserve plus career reserve.

The tables show the flows into and out of each of the 112 categories. For flows in we show (per year) the number augmented,* the number

*Augmentation takes place when a reserve officer is given a regular commission. Only the reserve force can have "augmentations out," and only the regular force can have "augmentations in."

promoted, and the number retained from the year before. We then show the total number of men in a given category for that year. Flows out include the number of men retained for the next year, the numbers augmented and promoted, and the number of men retired. For each year and, of course, for each category, the flow in should equal the total in category, which should equal the total flow out.

Computation of Career Flow

Assume a combination of category and rating of interest. Let N_{gj} be the number in grade g with year of service j. We assume that we have available a set of retention rates, r_j, pertaining to the category and rating that have been corrected for promotion force-outs. Associated with each grade and year of service combination, we have:

$$\text{Number} = N_{gj}$$

$$\text{Retire} = R_{gj} = (1 - r_j)N_{gj}$$

$$\text{Promote out} = P_{gj} = \sum_{i=g+1}^{b} [N_{i,j+1} - r_{j+1}N_{i,j}] .$$

(This is the total number of people in all higher grades, one year older, that did not get there by being retained in grade for one year. The only way they could have reached that grade was through promotion.)

$$\text{Number retained in grade} = r_j N_{g,j} - P_{g,j} .$$

(This is the number not retiring minus the number promoted.)

In case the category is reserve (regular) we have augmentation out (in). The amount of augmentation can be determined as follows.

Let N_j be the total number of regular officers in year j for all grades. Those in year j + 1 that were not retained in from year j must have been augmented (they were not promoted, since we are taking the total over all grades). Therefore, the number of augmented personnel out of year j (meaning reserve in year j, regular in year j + 1) is

$$A_j = N_{j+1} - r_j N_j$$

and the number augmented out of grade g in year j is

$$A_{gj} = X_{gj} A_j \ .$$

For regular and reserve categories the number retained and number promoted out are affected by augmentation.

For regulars, the number promoted out of a grade from year j is diminished by the number augmented into higher grades from this year. That number is

$$\sum_{i=g+1}^{6} X_{i,j+1} A_j \ .$$

For reserves, the number of men retained from year j is diminished by the number of men augmented out in year j.

Fudge Factor Versus Above-Zone Promotions

It was mentioned earlier that the difference between the two interpretations of the fudge factor will show up in the career flow. The input data to the program include a control card, which allows the user to specify which interpretation he is interested in.

If we include above-the-zone promotions in our model, the career-flow tables may show promotions in (or out) anywhere from the first year of the promotion zone to the year just before force-out. Without such promotions, however, we are merely adjusting retentions between one grade and the next. Promotions will take place only during the four years of the promotion zone, and the retentions and retirements will be slightly different with this interpretation. The same number who would have been promoted out above the zone in year j, grade g will be retired from grade g in year j and retained in grade g + 1 in year j + 1.

Percentage Tables

Each career-flow table has a matching percentage table which shows

certain relationships between promotion, retirement, and the total number in grade.

Three computations are shown in this table. For each year of the corresponding career-flow table we have:

a. The percentage in year j of the total promotions in, in the grade and category,

b. Of the total number in the category during year j, the percentage that was promoted out, in year j, and

c. Of the total number in the category during year j, the percentage that was retired during year j.

III. MODEL INPUTS AND OUTPUTS

INPUTS

The combined inputs to TOPLINE, except for the retention rates, define a personnel policy. They include accessions, training rates, lengths of initial commitments, force-out years, and promotion opportunities. Using these policy parameters and appropriate retention rates, TOPLINE estimates the long-term results of the policy, and thus helps the policy planner to evaluate his policy. Table 3 describes the inputs in detail. The FORTRAN variable names and array indexes (if applicable) are given, as well as a typical sample value and a short definition of the input.

Arrangement of Input Data

The program reads its input from a deck of 48 cards. The first 40 cards contain the 350 retention rates (a set of 35 rates for each of 10 categories). There are 4 cards per category, the first 3 of which contain 10 numbers each and the fourth contains the last 5 of the 35 rates. Figure 3 shows how to set up these data cards. In that figure the notation RETRAT(N,X-Y) means "retention rates for years X through Y, for the Nth category," so that "RETRAT(1,1-10)" would refer to the retention rates for the first 10 years of service for academy pilots (i.e., category 1).

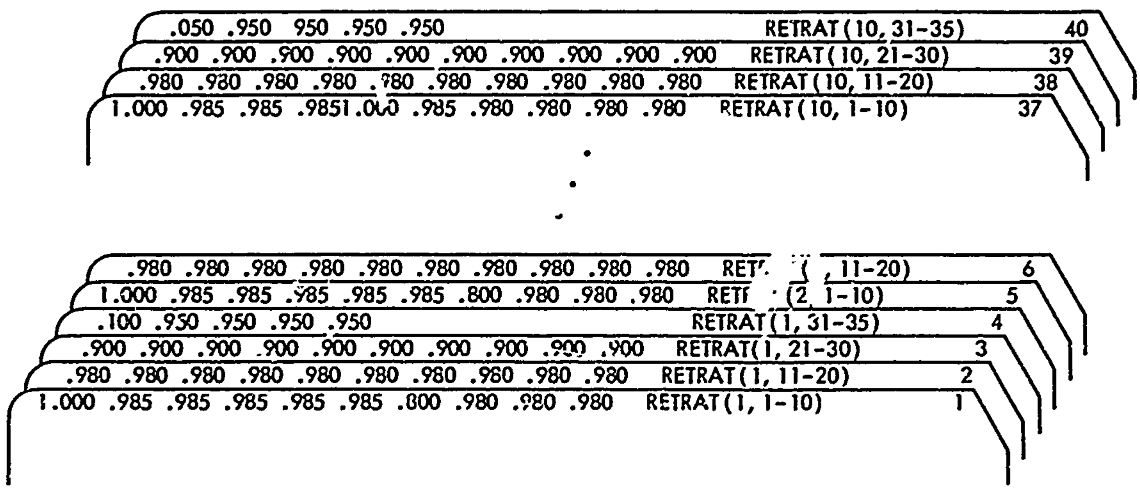
The next 3 data cards contain promotion opportunities. Card 41 is for pilots, card 42 is for navigators, and card 43 has promotion opportunities for nonrated officers. The setup for these cards is shown in Fig. 4. In this figure the opportunities shown are the same for all ratings; this, of course, is not necessary.

Card 44 contains the three adjustments for the fourth year of promotion zones. Recall that these were discussed in Sec. II under the heading Fourth-Year Promotion Opportunities. Card 45 is for officer totals (or requirements), and card 46 contains training rates. The training rate for academy graduates is called AFA, and the rest are in an array called T, which is partly input and partly computed in the program. These 3 cards are set up in Fig. 5.

Table 3

INPUT DATA TO TOPLINE STATIC MODEL

FORTRAN Name	Typical Value	Definition
REQ(1)	102900	Total number of officers
REQ(2)	60660	Total number of officers with regular commissions
REQ(3)	37500	Total number of pilots less than 06
REQ(4)	15000	Total number of navigators less than 06
AFA	960	Number of yearly academy graduates
T(1,1)	624	Number of yearly academy pilot graduates
T(1,2)	96	Number of yearly academy navigator graduates
T(1,3)	240	Number of yearly academy nonrated graduates
T(3,1)	310	Number of new contract pilots yearly
T(3,2)	310	Number of new contract navigators yearly
T(3,3)	325	Number of new contract nonrated yearly
COMEND(1)	6	Length of initial commitment for pilots
COMEND(2)	6	Length of initial commitment for navigators
COMEND(3)	4	Length of initial commitment for nonrated
FORCE(1)	16	Force-out year for captains
FORCE(2)	23	Force-out year for majors
FORCE(3)	29	Force-out year for lieutenant colonels
FORCE(4)	36	(always equals 36)
FSTPRO(1)	9	First year of promotion zone for captain to major
FSTPRO(2)	15	First year of promotion zone for major to lieutenant colonel
FSTPRO(3)	19	First year of promotion zone for lieutenant colonel to colonel
PROOP(I,J,K) I=1,3 J=1,4 K=1,3		Promotion opportunities: the first subscript indicates type of promotion (1 = captain to major, 2 = major to lieutenant colonel, 3 = lieutenant colonel to colonel), the second subscript indicates the first, second, third, or fourth year of the promotion zone, and the third subscript indicates rating (1 = pilot, 2 = navigator, 3 = nonrated)
ADJUST(1)	0.980	Adjustment for last year prom. opp. captain to major
ADJUST(2)	0.980	Adjustment for last year prom. opp. major to lieutenant colonel
ADJUST(3)	0.900	Adjustment for last year prom. opp. lieutenant colonel to colonel
PROFAC	0.01	Above-the-zone promotion factor or fudge factor
RETRAT(1,J) J=1,35		Retention rates, academy pilots
RETRAT(2,J) J=1,35		Retention rates, academy navigators
RETRAT(3,J) J=1,35		Retention rates, academy nonrated
RETRAT(4,J) J=1,35		Retention rates, other pilots
RETRAT(5,J) J=1,35		Retention rates, other navigators
RETRAT(6,J) J=1,35		Retention rates, contract pilots
RETRAT(7,J) J=1,35		Retention rates, contract navigators
RETRAT(8,J) J=1,35		Retention rates, contract nonrated
RETRAT(9,J) J=1,35		Retention rates, regular nonrated
RETRAT(10,J) J=1,35		Retention rates, reserve nonrated



These cards are divided into 5-column fields as follows:

Card 1: Cols. 1-5: Retention rate for year 1 of category 1 with 3 places right of decimal.

Cols. 6-10: Retention rate for year 2, category 1.

Cols. 11-50: Retention rates for years 3-10, same as for year 1 and 2.

Card 2: Cols. 1-50: Retention rates for years 11-20, same as for years 1-10.

Card 3: Cols. 1-50: Retention rates for years 21-30.

Card 4: Cols. 1-25: Retention rates for years 31-35.

Cards 5-8: Retention rates for category 2, same as for category 1.

•   •
•   •
•   •

Cards 37-40: Retention rates for category 10.

Fig. 3—Card format for retention rate data

.010 .050 .800 .900 .020 .060 .650 .750 .020 .040 .350 .500 PROOP NONRTD 43
.010 .050 .800 .900 .020 .060 .650 .750 .020 .040 .350 .500 PROOP NAVIGS 42
.010 .050 .800 .900 .020 .060 .650 .750 .020 .040 .350 .500 PROOP PILOTS 41

These cards are each divided into twelve 5-column fields as follows:

Card 41: Cols. 1-5: Promotion opportunity from captain to major; for pilots, 1st year of promotion zone; 3 places to right of decimal.

Cols. 6-10: Promotion opportunity from captain to major; for pilots, 2nd year of zone.

Cols. 11-15: Promotion opportunity from captain to major; for pilots, 3rd year of zone.

Cols. 16-20: Promotion opportunity from captain to major; for pilots, 4th year of zone.

Cols. 21-40: Promotion opportunity from major to lieutenant colonel; same as above.

Cols. 41-60: Promotion opportunity from lieutenant colonel to colonel; same as above.

Card 42: Promotion opportunities for navigators, set up same as card 41.

Card 43: Opportunities for nonrated officers, same as for pilots and navigators.

Fig. 4—Card format for input of promotion opportunities

```
960   624   96  240  310  310  325          "AFA" AND "T"      46
102900 60660 37500 15000                     REQ(1-4)           45
.980 .980 .900                               ADJUST             44
```

Card 44 uses 5-column fields:

Cols. 1-5: Adjustment for fourth year of promotion zone from captain to major.

Cols. 6-10: Adjustment for fourth year of promotion zone from major to lieutenant colonel.

Cols. 11-15: Adjustment for fourth year of promotion zone from lieutenant colonel to colonel.

Note that the fourth-year adjustments are the same across ratings.

Card 45 uses 6-column fields:

Cols. 1-6: Total number of officers.

Cols. 7-12: Total academy graduates in the officer force.

Cols. 13-18: Total number of pilots.

Cols. 19-24: Total number of navigators.

On 46 we again use 5-column fields:

Cols. 1-5: AFA, no places after decimal.

Cols. 6-10: T(1, 1) same as for AFA (see Table 3 for definitions of these numbers).

Cols. 11-15: T(1, 2).

Cols. 16-20: T(1, 3).

Cols. 21-25: T(3, 1).

Cols. 26-30: T(3, 2).

Cols. 31-35: T(3, 3).

Fig. 5—Card format for input of promotion adjustments, officer requirements, and training rates

Card 47 has the values for three short arrays on it (COMEND, FORCE, and FSTPRO; see Table 2). This card and card 48 which is the control care for fudge factor interpretations are shown in Fig. 6.

A listing of a sample data deck is shown on p. 35. Note, from cards 31 and 32, that zeros may be replaced by blanks.

OUTPUTS

A sample of the program outputs is given in Appendix A. This discussion is keyed to that appendix, and the pages and tables referred to here are the pages of Appendix A.

The first page of the output, Table A-1, is a listing of all program inputs. The ten columns of the retention rates matrix are the ten categories for which we have retention rates. (Descriptions of these categories that are clearer than the acronyms across the top of the matrix can be found in Table 3.) The rest of the inputs are printed out in the same order as they appear on the data cards.

Tables A-2, A-4 and A-6 are distribution tables, one for each rating. These show the proportions of officers in each grade by year. For example, in year 1, for pilots (Table A-2), the proportion of lieutenants to captains is 1.000 as compared to 0.0 for the other grades. This means that 100 percent of all officers in their first year of service are lieutenants or captains. In year 15, the proportions are 0.0516 for lieutenants and/or captains, 0.9294 for majors, 0.0190 for lieutenant colonels, and 0.0 for colonels and/or generals. This means that 5.16 percent of all officers with 15 years of service are lieutenants or captains, 92.94 percent are majors, 1.9 percent are lieutenant colonels, and none are colonels. Note that these add up to 100 percent. The grade proportions should add up to 1.0 for each year of service. Between the grade proportion columns there are three extra columns headed "OPP." These columns show the opportunities, for each year, of being promoted from the grade on the left to the grade on the right of the promotion opportunity column.

For each distribution table there is a corresponding table which shows the actual number of men in each grade per year rather than just the relative proportions. These are Tables A-3, A-5, and A-7, one for

```
1  1=FUDGE FACTOR, 0=ABOVE THE ZONE PROMOTIONS                        48
6    6    4    16    23    29    36    9    15    19   COMEND,FORCE, FSTPRO   47
```

Card 47 is set up with 5-column fields as follows:

Cols. 1-5:	COMEND (1), end of initial commitment for pilots.
Cols. 6-15:	COMEND (2), COMEND (3), end of initial commitments for navigators and nonrated.
Cols. 16-20:	FORCE (1), force-out year for captains.
Cols. 21-35:	FORCE (2-4) force-out years for majors, lieutenant colonels, and colonels (this last is always 36).
Cols. 36-40:	FSTPRO (1) first year of promotion zone from captain to major.
Cols. 41-50:	FSTPRO (2), FSTPRO(3).

Card 48 is the control card which allows the user to chose between the two interpretations of the "fudge factor." (The fudge factor, by the way, is set in the program.) A 0 in Col. 1 of card 48 means that the user wishes to include above-the-zone promotions in his policy. A 1 in the first column means he would like to see the effect that promotion has on retention.

Fig. 6—Card format for input of end of commitment, force-out, and promotion zone years

```
1.000 .985 .985 .985 .985 .985 .800 .980 .980 .980  RETRAT(1,1-10)        1
 .980 .980 .980 .980 .980 .980 .980 .980 .980 .980  RETRAT(1,11-20)       2
 .900 .900 .900 .900 .900 .900 .900 .900 .900 .900  RETRAT(1,21-30)       3
 .100 .950 .950 .950 .950                           RETRAT(1,31-35)       4
1.000 .985 .985 .985 .985 .985 .800 .980 .980 .980  RETRAT(2,1-10)        5
 .980 .980 .980 .980 .980 .980 .980 .980 .980 .980  RETRAT(2,11-20)       6
 .900 .900 .900 .900 .900 .900 .900 .900 .900 .900  RETRAT(2,21-30)       7
 .100 .950 .950 .950 .950                           RETRAT(2,31-35)       8
1.000 .985 .985 .985 .800 .985 .980 .980 .980 .980  RETRAT(3,1-10)        9
 .980 .980 .980 .980 .980 .980 .980 .980 .980 .980  RETRAT(3,11-20)      10
 .900 .900 .900 .900 .900 .900 .900 .900 .900 .900  RETRAT(3,21-30)      11
 .050 .950 .950 .950 .950                           RETRAT(3,31-35)      12
1.000 .985 .985 .985 .985 .985 .400 .980 .980 .980  RETRAT(4,1-10)       13
 .980 .980 .980 .980 .980 .980 .980 .980 .980 .980  RETRAT(4,11-20)      14
 .900 .900 .900 .900 .900 .900 .900 .900 .900 .900  RETRAT(4,21-30)     15
 .100 .950 .950 .950 .950                           RETRAT(4,31-35)      16
1.000 .985 .985 .985 .985 .985 .300 .980 .980 .980  RETRAT(5,1-10)       17
 .980 .980 .980 .980 .980 .980 .980 .980 .980 .980  RETRAT(5,11-20)      18
 .900 .900 .900 .900 .900 .900 .900 .900 .900 .900  RETRAT(5,21-30)      19
 .010 .950 .950 .950 .950                           RETRAT(5,31-35)      20
1.0001.0001.0001.0001.0001.0001.000 .980 .980 .980  RETRAT(6,1-10)       21
 .980 .980 .980 .980 .980 .980 .980 .980 .980 .980  RETRAT(6,11-20)      22
    0    0    0    0    0    0    0    0    0    0  RETRAT(6,21-30)      23
    0    0    0    0    0                           RETRAT(6,31-35)      24
1.0001.0001.0001.0001.0001.0001.000 .980 .980 .980  RETRAT(7,1-10)       25
 .980 .980 .980 .980 .980 .980 .980 .980 .980 .980  RETRAT(7,11-20)      26
    0    0    0    0    0    0    0    0    0    0  RETRAT(7,21-30)      27
    0    0    0    0    0                           RETRAT(7,31-35)      28
1.0001.0001.0001.0001.000 .980 .980 .980 .980 .980  RETRAT(8,1-10)       29
 .980 .980 .980 .980 .980 .980 .980 .980 .980 .980  RETRAT(8,11-20)      30
                                                    RETRAT(8,21-30)      31
                                                    RETRAT(8,31-35)      32
1.000 .985 .985 .9851.000 .985 .980 .980 .980 .980  RETRAT(9,1-10)       33
 .980 .980 .980 .980 .980 .980 .980 .980 .980 .980  RETRAT(9,11-20)      34
 .900 .900 .900 .900 .900 .900 .900 .900 .900 .900  RETRAT(9,21-30)      35
 .050 .950 .950 .950 .950                           RETRAT(9,31-35)      36
1.000 .985 .985 .9851.000 .985 .980 .980 .980 .980  RETRAT(10,1-10)      37
 .980 .980 .980 .980 .980 .980 .980 .980 .980 .980  RETRAT(10,11-20)     38
 .900 .900 .900 .900 .900 .900 .900 .900 .900 .900  RETRAT(10,21-30)     39
 .050 .950 .950 .950 .950                           RETRAT(10,31-35)     40
 .010 .050 .800 .900 .020 .060 .650 .750 .020 .040 .350 .500  PROOP PILOTS  41
 .010 .050 .800 .900 .020 .060 .650 .750 .020 .040 .350 .500  PROOP NAVIGS  42
 .010 .050 .800 .900 .020 .060 .650 .750 .020 .040 .350 .500  PROOP NONRTO  43
 .980 .980 .900                                ADJUST                     44
102900 60660 37500 15000                        REQ(1-4)                  45
  960  624   96  240  310  310  325              "AFA"  AND "T"           46
    6    6    4   16   23   29   36    9   15   19  CONFNO,FORCE, FSTPRO  47
1  1=FUDGE FACTOR , 0=ABOVE THE ZONE PROMOTIONS                          48
                                                                  0048 CARDS
```

Fig. 7—Listing of data deck

each rating. For each year of service, the relationship between the number of men in each grade and the total number of men in that year of service should be the same as the proportions shown in the corresponding distribution table. Note that because our example has equal promotion opportunities per rating, the distribution tables are all identical, but since training rates (i.e., first-year inputs) differ by rating this does not imply that corresponding tables of officer counts will be the same. Also, we have no pilots or navigators in year 1 because they are in training during that year (rated officers in training are considered nonrated and are counted as such). Table A-8 is similar to Tables A-3, A-5, and A-7, but it includes all the Air Force line officers. It was obtained by simply adding together Tables A-3, A-5, and A-7 (except for the average year of service row, which shows the average year of service for each column of the table).

Table A-9 tabulates officers who are lieutenant colonels or of lesser rank by rating and component. Recall that contract officers (CONTR) are differentiated from reserve officers in that contract refers to career reserve officers, while reserve (as used here) refers to those officers in the reserve component who have not reached the end of their initial commitment. Since the two terms are mutually exclusive, the columns for contract officers show counts of 0.0 until the end of initial commitment.

Table A-10 shows counts of various different types. The first three columns are counts by rating of officers whose grades are above lieutenant colonel (i.e., colonels and generals). Since there are no more contract officers after year 20, these officers were not divided between components. We next have a column of counts for academy graduates, one for other regular officers and one for all contract officers.

Table A-11 tabulates the reserve officers. Since reserve does not include contract, this table stops with the end of the longest initial commitment.

Table A-12 shows training rates for regular rated officers. Regular is divided up between academy graduates (AFA) and other regular officers.

Tables A-13 and A-14 are examples of career-flow tables. They are actually the same table, but A-13 has the above-the-zone promotion interpretation of the fudge factor and A-14 has the interpretation that shows the effect of promotion on retention. Note that in Table A-13. both promotions in and promotions out continue to occur beyond the four promotion zone years. They take place, in fact, up until the force-out year for the grade being promoted. These, of course, are above-the-zone promotions. In Table A-14, instead, we only have promotions during the four years of the promotion zone, but on the "In" side we are retaining more of those men who *did* get promoted and on the "Out" side we are losing some men who, in Table A-13, were promoted to lieutenant colonels.

Below the career-flow table there is the table of proportions that was mentioned in Sec. II. The column labeled "% of Total Promotions" can be thought of as the answer to the question, Of all promotions to major for regular pilots, what proportion of them took place in year N? The next column answers the question, Of all the regular pilots with grade major in year N, what proportion of them are promoted to lieutenant colonel in year N? These numbers can be thought of as promotion opportunities. They do not come out the same as opportunities which were input because of (1) round-off error, and (2) they are not cumulative as are the input opportunities. The third column of proportions answers the question, Of all the regular pilots with grade major in year N, what proportion of them retire in year N? This gives a set of loss rates as opposed to the retention rates which were input.

IV. CONCLUSIONS

As previously mentioned, the TOPLINE model has already played an important role in developing the USAF personnel plan for line officers. This plan includes a long-term objective officer structure, which was arrived at with aid from the TOPLINE Static Flow Model.

This model is very useful as a tool in designing long-term objective structures and as an aid in testing the effects of changes in various policy variables. For example, a planner can experiment with promotion opportunities to help him better understand what sort of promotion policy gives the best ratio of rated to nonrated officers in the higher grades. He can test the effect that the training rates for undergraduate pilot or navigator training have on the same problem, or he can work with both training rates and promotion policy in an effort to learn how to manage the average age of the force (does he desire a younger or older force, and how does he go about reaching this goal?). TOPLINE, of course, will not give him an exact real-world picture; i.e., the structure output by TOPLINE is not exactly what he will get if the policies input are put into action. The reason for this is that TOPLINE is not affected by past policy or present real-world conditions, the influence of which can take years to eliminate. What TOPLINE does do is give the planner a good idea of the *direction* in which certain policies will take the force. He can get an overall, general idea of the effect such policies have and the types of changes they will encourage. This can be extremely useful information that may be difficult to arrive at without some mathematical aid, especially when various parameters are interacting with one another or when the planner wishes to see the degree of difference between several policies.

While the summary tables (all of the output except career-flow tables) give the planner a "snapshot" of the officer structure in question, the more detailed career-flow tables allow him to see the actual movements that are taking place within that structure. The picture he gets tells him what would happen if the input policy had been in use for

many years without change. This information, of course, allows him to decide what the value of the particular policy might be and whether it would be useful in reaching officer structure objectives.

Appendix A

SAMPLE OUTPUT OF THE FORTRAN PROGRAM

These outputs are explained in detail in Sec. III, under the heading "Outputs." Recall that the first page of output is a listing of program inputs. For this sample we used the same promotion opportunities for all three ratings, so the three tables showing distribution of grades are identical. Note also that on the career-flow tables only years 9 to 22 are shown, because there are no majors before year 9 or after year 22.

Table A-1

PROGRAM INPUTS

RETENTION RATES

	R(1,.)	R(2,.)	R(3,.)	R(4,.)	R(5,.)	R(6,.)	R(7,.)	R(8,.)	R(9,.)	R(10,.)
YEAR	RAP	RAN	RANK	ROP	KON	CONP	CONN	CONT	REGNR	RESNR
1	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
2	0.985	0.985	0.985	0.985	0.985	1.000	1.000	1.000	0.985	0.985
3	0.985	0.985	0.985	0.985	0.985	1.000	1.000	1.000	0.985	0.985
4	0.985	0.985	0.985	0.985	0.985	1.000	1.000	1.000	0.985	0.985
5	0.985	0.985	0.800	0.985	0.985	1.000	1.000	1.000	1.000	1.000
6	0.985	0.985	0.985	0.985	0.985	1.000	1.000	0.980	0.985	0.985
7	0.800	0.800	0.980	0.400	0.300	1.000	1.000	0.980	0.980	0.980
8	0.980	0.980	0.980	0.980	0.980	0.980	0.980	0.980	0.980	0.980
9	0.980	0.980	0.980	0.980	0.980	0.980	0.980	0.980	0.980	0.960
10	0.980	0.980	0.980	0.980	0.980	0.980	0.980	0.980	0.980	0.980
11	0.980	0.980	0.980	0.980	0.980	0.980	0.980	0.980	0.980	0.980
12	0.980	0.980	0.980	0.980	0.980	0.980	0.980	0.980	0.980	0.980
13	0.980	0.980	0.980	0.980	0.980	0.980	0.980	0.980	0.980	0.980
14	0.980	0.930	0.980	0.980	0.980	0.980	0.980	0.980	0.980	0.980
15	0.980	0.980	0.980	0.980	0.980	0.980	0.980	0.980	0.980	0.980
16	0.980	0.980	0.980	0.980	0.980	0.980	0.980	0.980	0.980	0.980
17	0.980	0.980	0.980	0.980	0.980	0.980	0.980	0.980	0.980	0.980
18	0.980	0.980	0.980	0.980	0.980	0.980	0.980	0.980	0.980	0.980
19	0.980	0.980	0.980	0.980	0.980	0.980	0.980	0.980	0.980	0.980
20	0.980	0.960	0.980	0.980	0.980	0.980	0.980	0.980	0.980	0.980
21	0.900	0.900	0.900	0.900	0.900	0.0	0.0	0.0	0.900	0.900
22	0.900	0.900	0.900	0.900	0.900	0.0	0.0	0.0	0.900	0.900
23	0.900	0.900	0.900	0.900	0.900	0.0	0.0	0.0	0.900	0.900
24	0.900	0.900	0.900	0.900	0.900	0.0	0.0	0.0	0.900	0.900
25	0.900	0.900	0.900	0.900	0.900	0.0	0.0	0.0	0.900	0.900
26	0.900	0.900	0.900	0.900	0.900	0.0	0.0	0.0	0.900	0.900
27	0.900	0.900	0.900	0.900	0.900	0.0	0.0	0.0	0.900	0.900
28	0.900	0.900	0.900	0.900	0.900	0.0	0.0	0.0	0.900	0.900
29	0.900	0.900	0.900	0.900	0.900	0.0	0.0	0.0	0.900	0.900
30	0.900	0.900	0.900	0.900	0.900	0.0	0.0	0.0	0.900	0.900
31	0.100	0.100	0.050	0.100	0.010	0.0	0.0	0.0	0.050	0.050
32	0.950	0.950	0.950	0.950	0.950	0.0	0.0	0.0	0.950	0.950
33	0.950	0.950	0.950	0.950	0.950	0.0	0.0	0.0	0.950	0.950
34	0.950	0.950	0.950	0.950	0.950	0.0	0.0	0.0	0.950	0.950
35	0.950	0.950	0.950	0.950	0.950	0.0	0.0	0.0	0.950	0.950

PRO UP PILOTS=	0.010	0.050	0.800	0.900	0.020	0.060	0.650	0.750	0.020	0.040	0.350	0.500
PRO UP NAVIGS=	0.010	0.050	0.800	0.900	0.020	0.060	0.650	0.750	0.020	0.040	0.350	0.500
PRO UP NONRTD=	0.010	0.050	0.800	0.900	0.020	0.060	0.650	0.750	0.020	0.040	0.350	0.500

```
ADJUST=    0.960    0.960    0.900
REQ(1-4)=    102900.    60600.    37500.    15000.
AFA=  960.          T=     624.      96.     240.     310.     310.     325.

COMBNO=    6    6    4 FORCE=     16.     23.     29.     36. FSTPRO=     9.     15.     19.
```

Table A-2

DISTRIBUTION OF GRADES BY YEAR FOR PILOTS

YEAR	LT/CAPT	GPP	MAJOR	UPP	LT COL	OPP	COL/GEN
1	1.0000	0.0	0.0	0.0	0.0	0.0	0.0
2	1.0000	0.0	0.0	0.0	0.0	0.0	0.0
3	1.0000	0.0	0.0	0.0	0.0	0.0	0.0
4	1.0000	0.0	0.0	0.0	0.0	0.0	0.0
5	1.0000	0.0	0.0	0.0	0.0	0.0	0.0
6	1.0000	0.0	0.0	0.0	0.0	0.0	0.0
7	1.0000	0.0	0.0	0.0	0.0	0.0	0.0
8	1.0000	0.0	0.0	0.0	0.0	0.0	0.0
9	0.9900	0.01	0.0100	0.0	0.0	0.0	0.0
10	0.9500	0.05	0.0500	0.0	0.0	0.0	0.0
11	0.2000	0.80	0.8000	0.0	0.0	0.0	0.0
12	0.0816	0.90	0.9184	0.0	0.0	0.0	0.0
13	0.0716	0.0	0.9284	0.0	0.0	0.0	0.0
14	0.0616	0.0	0.9384	0.0	0.0	0.0	0.0
15	0.0516	0.0	0.9294	0.02	0.0190	0.0	0.0
16	0.0	0.0	0.9400	0.06	0.0600	0.0	0.0
17	0.0	0.0	0.3500	0.65	0.6500	0.0	0.0
18	0.0	0.0	0.2347	0.75	0.7653	0.0	0.0
19	0.0	0.0	0.2247	0.0	0.7598	0.02	0.0155
20	0.0	0.0	0.2147	0.0	0.7539	0.04	0.0314
21	0.0	0.0	0.2047	0.0	0.5169	0.25	0.2784
22	0.0	0.0	0.1947	0.0	0.3579	0.50	0.4474
23	0.0	0.0	0.0	0.0	0.4344	0.0	0.5656
24	0.0	0.0	0.0	0.0	0.4244	0.0	0.5756
25	0.0	0.0	0.0	0.0	0.4144	0.0	0.5856
26	0.0	0.0	0.0	0.0	0.4044	0.0	0.5956
27	0.0	0.0	0.0	0.0	0.3944	0.0	0.6056
28	0.0	0.0	0.0	0.0	0.3844	0.0	0.6156
29	0.0	0.0	0.0	0.0	0.0	0.0	1.0000
30	0.0	0.0	0.0	0.0	0.0	0.0	1.0000
31	0.0	0.0	0.0	0.0	0.0	0.0	1.0000
32	0.0	0.0	0.0	0.0	0.0	0.0	1.0000
33	0.0	0.0	0.0	0.0	0.0	0.0	1.0000
34	0.0	0.0	0.0	0.0	0.0	0.0	1.0000
35	0.0	0.0	0.0	0.0	0.0	0.0	1.0000

Table A-3

PILOTS BY GRADE AND YEAR

YEAR	LT/CAPT	MAJOR	LT COL	COL/GEN	TOTAL	
1	0.	0.	0.	0.	0.	1
2	3055.	0.	0.	0.	3055.	2
3	3009.	0.	0.	0.	3009.	3
4	2964.	0	0.	0.	2964.	4
5	2919.	0.	0.	0.	2919.	5
6	2875.	0.	0.	0.	2875.	6
7	1692.	0.	0.	0.	1692.	7
8	1658.	0.	0.	0.	1658.	8
9	1608.	16.	0.	0.	1625.	9
10	1513.	80.	0.	0.	1592.	10
11	312.	1248.	0.	0.	1560.	11
12	125.	1404.	0.	0.	1529.	12
13	107.	1391.	0.	0.	1499.	13
14	91.	1378.	0.	0.	1469.	14
15	74.	1338.	27.	0.	1439.	15
16	0.	1257.	80.	0.	1338.	16
17	0.	459.	852.	0.	1311.	17
18	0.	301.	983.	0.	1285.	18
19	0.	283.	957.	20.	1259.	19
20	0.	265.	930.	39.	1234.	20
21	0.	186.	469.	252.	907.	21
22	0.	159.	292.	365.	816.	22
23	0.	0.	257.	335.	592.	23
24	0.	0.	226.	306.	532.	24
25	0.	0.	199.	281.	479.	25
26	0.	0.	174.	257.	431.	26
27	0.	0.	153.	235.	388.	27
28	0.	0.	134.	215.	349.	28
29	0.	0.	0.	194.	194.	29
30	0.	0.	0.	174.	174.	30
31	0.	0.	0.	17.	17.	31
32	0.	0.	0.	17.	17.	32
33	0.	0.	0.	16.	16.	33
34	0.	0.	0.	15.	15.	34
35	0.	0.	0.	14.	14.	35
TOTAL	22001.	9765.	5734.	2751.	40251.	

AVERAGE YEAR OF SERVICE

	LT/CAPT	MAJOR	LT COL	COL/GEN	TOTAL
	5.56	14.38	20.17	25.09	11.11

Table A-4

DISTRIBUTION OF GRADES BY YEAR FOR NAVIGATORS

YEAR	LT/CAPT	OPP	MAJOR	OPP	LT COL	OPP	COL/GEN
1	1.0000	0.0	0.0	0.0	0.0	0.0	0.0
2	1.0000	0.0	0.0	0.0	0.0	0.0	0.0
3	1.0000	0.0	0.0	0.0	0.0	0.0	0.0
4	1.0000	0.0	0.0	0.0	0.0	0.0	0.0
5	1.0000	0.0	0.0	0.0	0.0	0.0	0.0
6	1.0000	0.0	0.0	0.0	0.0	0.0	0.0
7	1.0000	0.0	0.0	0.0	0.0	0.0	0.0
8	1.0000	0.0	0.0	0.0	0.0	0.0	0.0
9	0.9900	0.01	0.0100	0.0	0.0	0.0	0.0
10	0.9500	0.05	0.0500	0.0	0.0	0.0	0.0
11	0.2000	0.80	0.8000	0.0	0.0	0.0	0.0
12	0.0816	0.90	0.9184	0.0	0.0	0.0	0.0
13	0.0716	0.0	0.9284	0.0	0.0	0.0	0.0
14	0.0616	0.0	0.9384	0.0	0.0	0.0	0.0
15	0.0516	0.0	0.9294	0.02	0.0190	0.0	0.0
16	0.0	0.0	0.9400	0.06	0.0600	0.0	0.0
17	0.0	0.0	0.3500	0.65	0.6500	0.0	0.0
18	0.0	0.0	0.2347	0.75	0.7653	0.0	0.0
19	0.0	0.0	0.2247	0.0	0.7598	0.02	0.0155
20	0.0	0.0	0.2147	0.0	0.7539	0.04	0.0314
21	0.0	0.0	0.2047	0.0	0.5169	0.35	0.2784
22	0.0	0.0	0.1947	0.0	0.3579	0.50	0.4474
23	0.0	0.0	0.0	0.0	0.4344	0.0	0.5656
24	0.0	0.0	0.0	0.0	0.4244	0.0	0.5756
25	0.0	0.0	0.0	0.0	0.4144	0.0	0.5856
26	0.0	0.0	0.0	0.0	0.4044	0.0	0.5956
27	0.0	0.0	0.0	0.0	0.3944	0.0	0.6056
28	0.0	0.0	0.0	0.0	0.3844	0.0	0.6156
29	0.0	0.0	0.0	0.0	0.0	0.0	1.0000
30	0.0	0.0	0.0	0.0	0.0	0.0	1.0000
31	0.0	0.0	0.0	0.0	0.0	0.0	1.0000
32	0.0	0.0	0.0	0.0	0.0	0.0	1.0000
33	0.0	0.0	0.0	0.0	0.0	0.0	1.0000
34	0.0	0.0	0.0	0.0	0.0	0.0	1.0000
35	0.0	0.0	0.0	0.0	0.0	0.0	1.0000

Table A-5

NAVIGATORS BY GRADE AND YEAR

YEAR	LT/CAPT	MAJOR	LT COL	COL/GEN	TOTAL	
1	0.	0.	0.	0.	0.	1
2	1221.	0.	0.	0.	1221.	2
3	1202.	0.	0.	0.	1202.	3
4	1184.	0.	0.	0.	1184.	4
5	1166.	0.	0.	0.	1166.	5
6	1149.	0.	0.	0.	1149.	6
7	699.	0.	0.	0.	699.	7
8	685.	0.	0.	0.	685.	8
9	665.	7.	0.	0.	672.	9
10	625.	33.	0.	0.	658.	10
11	129.	516.	0.	0.	645.	11
12	52.	580.	0.	0.	632.	12
13	44.	575.	0.	0.	619.	13
14	37.	570.	0.	0.	607.	14
15	31.	553.	11.	0.	595.	15
16	0.	520.	33.	0.	553.	16
17	0.	190.	352.	0.	542.	17
18	0.	125.	406.	0.	531.	18
19	0.	117.	395.	8.	520.	19
20	0.	109.	384.	16.	510.	20
21	0.	52.	132.	71.	255.	21
22	0.	45.	82.	103.	230.	22
23	0.	0.	72.	94.	167.	23
24	0.	0.	64.	86.	150.	24
25	0.	0.	56.	79.	135.	25
26	0.	0.	49.	72.	121.	26
27	0.	0.	43.	66.	109.	27
28	0.	0.	38.	61.	98.	28
29	0.	0.	0.	55.	55.	29
30	0.	0.	0.	49.	49.	30
31	0.	0.	0.	1.	1.	31
32	0.	0.	0.	1.	1.	32
33	0.	0.	0.	1.	1.	33
34	0.	0.	0.	1.	1.	34
35	0.	0.	0.	1.	1.	35
TOTAL	8890.	3991.	2119.	766.	15766.	

AVERAGE YEAR OF SERVICE

5.59	14.29	19.76	24.87	10.64

Table A-6

DISTRIBUTION OF GRADES BY YEAR FOR NONRATED MEN

YEAR	LT/CAPT	OPP	MAJOR	OPP	LT COL	OPP	COL/GEN
1	1.0000	0.0	0.0	0.0	0.0	0.0	0.0
2	1.0000	0.0	0.0	0.0	0.0	0.0	0.0
3	1.0000	0.0	0.0	0.0	0.0	0.0	0.0
4	1.0000	0.0	0.0	0.0	0.0	0.0	0.0
5	1.0000	0.0	0.0	0.0	0.0	0.0	0.0
6	1.0000	0.0	0.0	0.0	0.0	0.0	0.0
7	1.0000	0.0	0.0	0.0	0.0	0.0	0.0
8	1.0000	0.0	0.0	0.0	0.0	0.0	0.0
9	0.9900	0.01	0.0100	0.0	0.0	0.0	0.0
10	0.9500	0.05	0.0500	0.0	0.0	0.0	0.0
11	0.2000	0.80	0.8000	0.0	0.0	0.0	0.0
12	0.0816	0.90	0.9184	0.0	0.0	0.0	0.0
13	0.0716	0.0	0.9284	0.0	0.0	0.0	0.0
14	0.0616	0.0	0.9384	0.0	0.0	0.0	0.0
15	0.0516	0.0	0.9294	0.02	0.0190	0.0	0.0
16	0.0	0.0	0.9400	0.06	0.0600	0.0	0.0
17	0.0	0.0	0.3500	0.65	0.6500	0.0	0.0
18	0.0	0.0	0.2347	0.75	0.7653	0.0	0.0
19	0.0	0.0	0.2247	0.0	0.7598	0.02	0.0155
20	0.0	0.0	0.2147	0.0	0.7539	0.04	0.0314
21	0.0	0.0	0.2047	0.0	0.5169	0.35	0.2784
22	0.0	0.0	0.1947	0.0	0.3579	0.50	0.4474
23	0.0	0.0	0.0	0.0	0.4344	0.0	0.5656
24	0.0	0.0	0.0	0.0	0.4244	0.0	0.5756
25	0.0	0.0	0.0	0.0	0.4144	0.0	0.5856
26	0.0	0.0	0.0	0.0	0.4044	0.0	0.5956
27	0.0	0.0	0.0	0.0	0.3944	0.0	0.6056
28	0.0	0.0	0.0	0.0	0.3844	0.0	0.6156
29	0.0	0.0	0.0	0.0	0.0	0.0	1.0000
30	0.0	0.0	0.0	0.0	0.0	0.0	1.0000
31	0.0	0.0	0.0	0.0	0.0	0.0	1.0000
32	0.0	0.0	0.0	0.0	0.0	0.0	1.0000
33	0.0	0.0	0.0	0.0	0.0	0.0	1.0000
34	0.0	0.0	0.0	0.0	0.0	0.0	1.0000
35	0.0	0.0	0.0	0.0	0.0	0.0	1.0000

Table A-7

NONRATED MEN BY GRADE AND YEAR

YEAR	LT/CAPT	MAJOR	LT COL	COL/GEN	TOTAL	
1	8162.	0.	0.	0.	8162.	1
2	3764.	0.	0.	0.	3764.	2
3	3708.	0.	0.	0.	3708.	3
4	3652.	0.	0.	0.	3652.	4
5	1680.	0.	0.	0.	1680.	5
6	1653.	0.	0.	0.	1653.	6
7	1620.	0.	0.	0.	1620.	7
8	1588.	0.	0.	0.	1588.	8
9	1540.	16.	0.	0.	1556.	9
10	1449.	76.	0.	0.	1525.	10
11	299.	1196.	0.	0.	1494.	11
12	120.	1345.	0.	0.	1465.	12
13	103.	1332.	0.	0.	1435.	13
14	87.	1320.	0.	0.	1407.	14
15	71.	1281.	26.	0.	1378.	15
16	0.	1204.	77.	0.	1281.	16
17	0.	439.	816.	0.	1255.	17
18	0.	289.	942.	0.	1230.	18
19	0.	271.	916.	19.	1206.	19
20	0.	254.	891.	37.	1182.	20
21	0.	176.	444.	239.	859.	21
22	0.	150.	277.	346.	773.	22
23	0.	0.	243.	317.	560.	23
24	0.	0.	214.	290.	504.	24
25	0.	0.	188.	266.	454.	25
26	0.	0.	165.	243.	408.	26
27	0.	0.	145.	223.	367.	27
28	0.	0.	127.	204.	331.	28
29	0.	0.	0.	183.	183.	29
30	0.	0.	0.	165.	165.	30
31	0.	0.	0.	8.	8.	31
32	0.	0.	0.	8.	8.	32
33	0.	0.	0.	7.	7.	33
34	0.	0.	0.	7.	7.	34
35	0.	0.	0.	7.	7.	35
TOTAL	29496.	9349.	5470.	2568.	46883.	

AVERAGE YEAR OF SERVICE

4.08	14.37	20.16	24.98	9.16

Table A-8

ALL OFFICERS BY GRADE AND YEAR

YEAR	LT/CAPT	MAJOR	LT COL	COL/GEN	TOTAL	
1	8162.	0.	0.	0.	8162.	1
2	8040.	0.	0.	0.	8040.	2
3	7919.	0.	0.	0.	7919.	3
4	7600.	0.	0.	0.	7600.	4
5	5766.	0.	0.	0.	5766.	5
6	5678.	0.	0.	0.	5678.	6
7	4011.	0.	0.	0.	4011.	7
8	3931.	0.	0.	0.	3931.	8
9	3814.	39.	0.	0.	3852.	9
10	3586.	189.	0.	0.	3775.	10
11	740.	2960.	0.	0.	3700.	11
12	296.	3330.	0.	0.	3626.	12
13	255.	3299.	0.	0.	3553.	13
14	215.	3267.	0.	0.	3482.	14
15	176.	3171.	65.	0.	3412.	15
16	0.	2981.	190.	0.	3171.	16
17	0.	1088.	2020.	0.	3108.	17
18	0.	715.	2331.	0.	3046.	18
19	0.	671.	2268.	46.	2985.	19
20	0.	623.	2205.	92.	2925.	20
21	0.	414.	1045.	563.	2021.	21
22	0.	354.	651.	614.	1619.	22
23	0.	0.	573.	746.	1318.	23
24	0.	0.	504.	683.	1186.	24
25	0.	0.	443.	625.	1068.	25
26	0.	0.	389.	572.	961.	26
27	0.	0.	341.	524.	865.	27
28	0.	0.	299.	479.	778.	28
29	0.	0.	0.	431.	431.	29
30	0.	0.	0.	388.	388.	30
31	0.	0.	0.	27.	27.	31
32	0.	0.	0.	26.	26.	32
33	0.	0.	0.	24.	24.	33
34	0.	0.	0.	23.	23.	34
35	0.	0.	0.	22.	22.	35
TOTAL	60387.	23105.	13323.	6085.	102900.	

AVERAGE YEAR OF SERVICE

	LT/CAPT	MAJOR	LT COL	COL/GEN	TOTAL
	4.84	14.36	20.10	25.01	10.15

Table A-9

NUMBER OF LIEUTENANT COLONELS AND RANKS BELOW

YEAR	REGULAR PILOTS	CONT PILOTS	REGULAR NAVIGS	CONT NAVIGS	REGULAR NONRTD	CONT NONRTD	TOTAL PILOTS	TOTAL NAVIGS	TOTAL NONRTD
1	0.	0.	0.	0.	960.	0.	0.	0.	8162.
2	615.	0.	95.	0.	236.	0.	3055.	1221.	3764.
3	605.	0.	93.	0.	819.	0.	3009.	1202.	3708.
4	969.	0.	221.	0.	1401.	0.	2964.	1184.	3652.
5	1425.	0.	380.	0.	1355.	325.	2919.	1166.	1680.
6	1497.	0.	407.	0.	1335.	318.	2875.	1149.	1653.
7	1382.	310.	389.	310.	1308.	312.	1692.	699.	1620.
8	1354.	304.	381.	304.	1282.	306.	1658.	685.	1588.
9	1327.	298.	374.	298.	1256.	300.	1625.	672.	1556.
10	1300.	292.	36[illegible].	292.	1231.	294.	1592.	658.	1525.
11	1274.	286.	359.	286.	1207.	288.	1560.	645.	1494.
12	1249.	280.	352.	280.	1182.	282.	1529.	632.	1465.
13	1224.	275.	345.	275.	1159.	276.	1499.	619.	1435.
14	1199.	269.	338.	269.	1136.	271.	1469.	607.	1407.
15	1175.	264.	331.	264.	1113.	266.	1439.	595.	1378.
16	1092.	245.	308.	245.	1034.	247.	1338.	553.	1281.
17	1071.	240.	302.	240.	1014.	242.	1311.	542.	1255.
18	1049.	235.	296.	235.	993.	237.	1285.	531.	1230.
19	1012.	227.	285.	227.	958.	229.	1239.	512.	1187.
20	976.	219.	275.	219.	924.	220.	1195.	494.	1145.
21	654.	0.	184.	0.	620.	0.	654.	184.	620.
22	451.	0.	127.	0.	427.	0.	451.	127.	427.
23	257.	0.	72.	0.	243.	0.	257.	72.	243.
24	226.	0.	64.	0.	214.	0.	226.	64.	214.
25	199.	0.	56.	0.	168.	0.	199.	56.	188.
26	174.	0.	49.	0.	165.	0.	174.	49.	165.
27	153.	0.	43.	0.	145.	0.	153.	43.	145.
28	134.	0.	38.	0.	127.	0.	134.	38.	127.
TOTAL	24046.	3744.	6530.	3744.	24032.	4413.	37500.	15000.	44315.

AVERAGE YEAR OF SERVICE

12.21	13.07	12.54	13.07	11.67	11.97	10.09	9.91	8.24

Table A-10

NUMBER OF COLONELS AND GENERALS, AND CATEGORY COUNTS

YEAR	COL/GEN PILOTS	COL/GEN NAVIGS	COL/GEN NONRTD	AFA TOTAL	OTH REG TOTAL	CONTRACT TOTAL
1	0.	0.	0.	960.	0.	0.
2	0.	0.	0.	946.	0.	0.
3	0.	0.	0.	931.	586.	0.
4	0.	0.	0.	917.	1674.	0.
5	0.	0.	0.	861.	2299.	325.
6	0.	0.	0.	848.	2391.	318.
7	0.	0.	0.	711.	2368.	932.
8	0.	0.	0.	697.	2320.	913.
9	0.	0.	0.	683.	2274.	895.
10	0.	0.	0.	669.	2228.	877.
11	0.	0.	0.	656.	2184.	860.
12	0.	0.	0.	643.	2140.	843.
13	0.	0.	0.	630.	2097.	826.
14	0.	0.	0.	617.	2055.	809.
15	0.	0.	0.	605.	2014.	793.
16	0.	0.	0.	562.	1872.	737.
17	0.	0.	0.	551.	1835.	722.
18	0.	0.	0.	540.	1798.	708.
19	20.	8.	19.	529.	1762.	694.
20	39.	16.	37.	519.	1727.	680.
21	25[illegible].	71.	239.	467.	1554.	0.
22	365.	103.	346.	420.	1399.	0
23	335.	94.	317.	305.	1014.	0.
24	306.	86.	290.	274.	912.	0.
25	281.	79.	266.	247.	821.	0.
26	257.	7[illegible].	243.	222.	739.	0.
27	235.	66.	223.	200.	665.	0.
28	215.	61.	204.	180.	599.	0.
29	194.	55.	183.	100.	332.	0.
30	174.	49.	165.	90.	298.	0.
31	17.	1.	8.	8.	19.	0.
32	17.	1.	8.	7.	18.	0.
33	16.	1.	7.	7.	17.	0.
34	15.	1.	7.	7.	16.	0.
35	14.	1.	7.	6.	16.	0.
TOTAL	2751.	706.	2568.	16616.	44044.	11933.

AVERAGE YEAR OF SERVICE

25.09	24.87	24.98	11.63	13.94	12.68

Table A-11

NUMBER OF RESERVES BY RATING AND YEAR

YEAR	PILOTS	NAVIGS	NONRTD	TOTAL
1	0.	0.	7202.	7202.
2	2440.	1126.	3528.	7094.
3	2403.	1109.	2889.	6402.
4	1995.	963.	2251.	5209.
5	1494.	786.	0.	2280.
6	1378.	742.	0.	2120.
TOTAL	9710.	4727.	15871.	30307.
AVERAGE YEAR OF SERVICE				
	3.69	3.77	2.01	2.62

Table A-12

TRAINING RATES

	PILOTS	NAVIGS
AFA	624.	96.
OTHER	2477.	1143.
TOTAL	3101.	1239.

Table A-13

CAREER FLOW TABLE WITH ABOVE-THE-ZONE PROMOTIONS

REGULAR

PILOTS

MAJOR

YEAR	AUGMENT	IN PROMOTE	RETAIN	TOTAL IN GRADE	RETAIN	OUT PROMOTE	AUGMENT	RETIRE
9	0.	13.	0.	13.	13.	0.	0.	0.
10	0.	52.	13.	65.	64.	0.	0.	1.
11	0.	956.	64.	1019.	999.	0.	0.	20.
12	0.	148.	999.	1147.	1124.	0.	0.	23.
13	0.	12.	1124.	1136.	1114.	0.	0.	23.
14	0.	12.	1114.	1126.	1081.	22.	0.	23.
15	0.	12.	1081.	1092.	1027.	44.	0.	22.
16	0.	0.	1027.	1027.	375.	632.	0.	21.
17	0.	0.	375.	375.	246.	121.	0.	7.
18	0.	0.	246.	246.	231.	10.	0.	5.
19	0.	0.	231.	231.	216.	10.	0.	5.
20	0.	0.	216.	216.	186.	9.	0.	22.
21	0.	0.	186.	186.	159.	8.	0.	19.
22	0.	0.	159.	159.	0.	0.	0.	159.
	0.	1205.	6834.	8039.	6834.	856.	0.	349.

YEAR	% OF TOTAL PROMOTIONS	PERCENT IN GRADE: (1) PROMOTED OUT	(2) RETIRED
9	0.0110	0.0	0.0200
10	0.0432	0.0	0.0200
11	0.7933	0.0	0.0200
12	0.1227	0.0	0.0200
13	0.0102	0.0	0.0200
14	0.0100	0.0198	0.0200
15	0.0098	0.0400	0.0200
16	0.0000	0.6151	0.0200
17	0.0000	0.3229	0.0200
18	0.0000	0.0418	0.0200
19	0.0000	0.0436	0.0200
20	0.0000	0.0419	0.1000
21	0.0000	0.0440	0.1000
22	0.0000	0.0	1.0000
	1.0000	0.1065	0.0434

Table A-14

CAREER FLOW TABLE WIHTOUT ABOVE-THE-ZONE PROMOTIONS,
BUT SHOWING EFFECT OF PROMOTION ON RETENTION

REGULAR

PILOTS

MAJOR

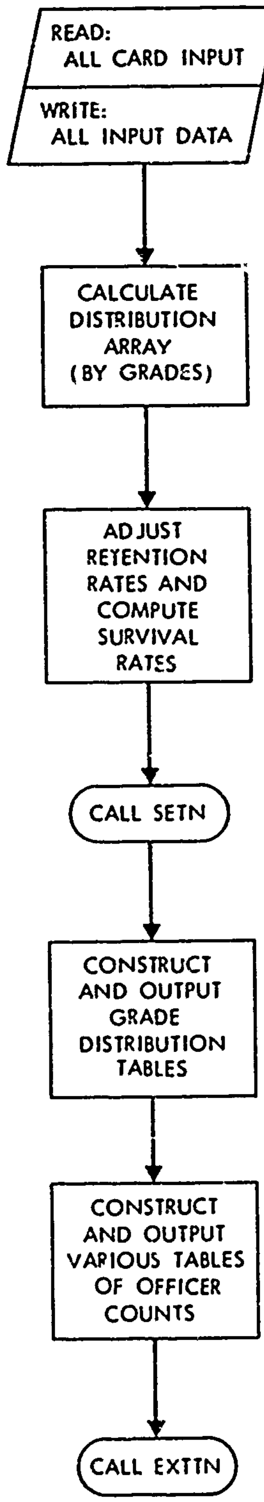
YEAR	AUGMENT	IN PROMOTE	RETAIN	TOTAL IN GRADE	RETAIN	OUT PROMOTE	AUGMENT	RETIRE
9	0.	13.	0.	13.	13.	0	0.	0.
10	0.	52.	13.	65.	64.	0.	0.	1.
11	0.	956.	64.	1019.	999.	0.	0.	20.
12	0.	148.	999.	1147.	1136.	0.	0.	11.
13	0.	0.	1136.	1136.	1126.	0.	0.	11.
14	0.	0.	1126.	1126.	1092.	[illegible]	0.	11.
15	0.	0.	1092.	1092.	1027.	44.	0.	22.
16	0.	0.	1027.	1027.	375.	632.	0.	21.
17	0.	0.	375.	375.	246.	121.	0.	7.
18	0.	0.	246.	246.	231.	0.	0.	15.
19	0.	0.	231.	231.	216.	0.	0.	15.
20	0.	0.	216.	216.	186.	0.	0.	31.
21	0.	0.	186.	186.	159.	0.	0.	27.
22	0.	0.	159.	159.	0.	0.	0.	159.
	0.	1169.	6870.	8039.	6870.	819.	0.	350.

YEAR	% OF TOTAL PROMOTIONS	PERCENT IN GRADE: (1) PROMOTED OUT	(2) RETIRED
9	0.0114	0.0	0.0200
10	0.0445	0.0	0.0200
11	0.8177	0.0	0.0200
12	0.1265	0.0	0.0093
13	0.0	0.0	0.0094
14	0.0	0.0198	0.0096
15	0.0	0.0400	0.0200
16	0.0	0.6151	0.0200
17	0.0	0.3229	0.0200
18	0.0	0.0	0.0618
19	0.0	0.0	0.0636
20	0.0	0.0	0.1419
21	0.0	0.0	0.1440
22	0.0	0.0	1.0000
	1.0000	0.1018	0.0436

Appendix B

SUMMARY FLOW CHARTS

This appendix presents two flow charts that outline briefly the program's two largest and most important routines. These should help the reader to get an idea of the flow of the program and the order of steps taken. The MAIN routine develops all the summary tables of the output, and the subroutine EXTTN creates and outputs the career-flow tables.



SETN is a routine that computes values for the N-array. The N-array is an array of officer counts by category, rating, grade, and year of service.

EXTTN is the routine that [illegible] computes, constructs, and outputs) the officer flow tables and their corresponding percentage tables

Fig. B-1—Logical flow of tasks in main routine

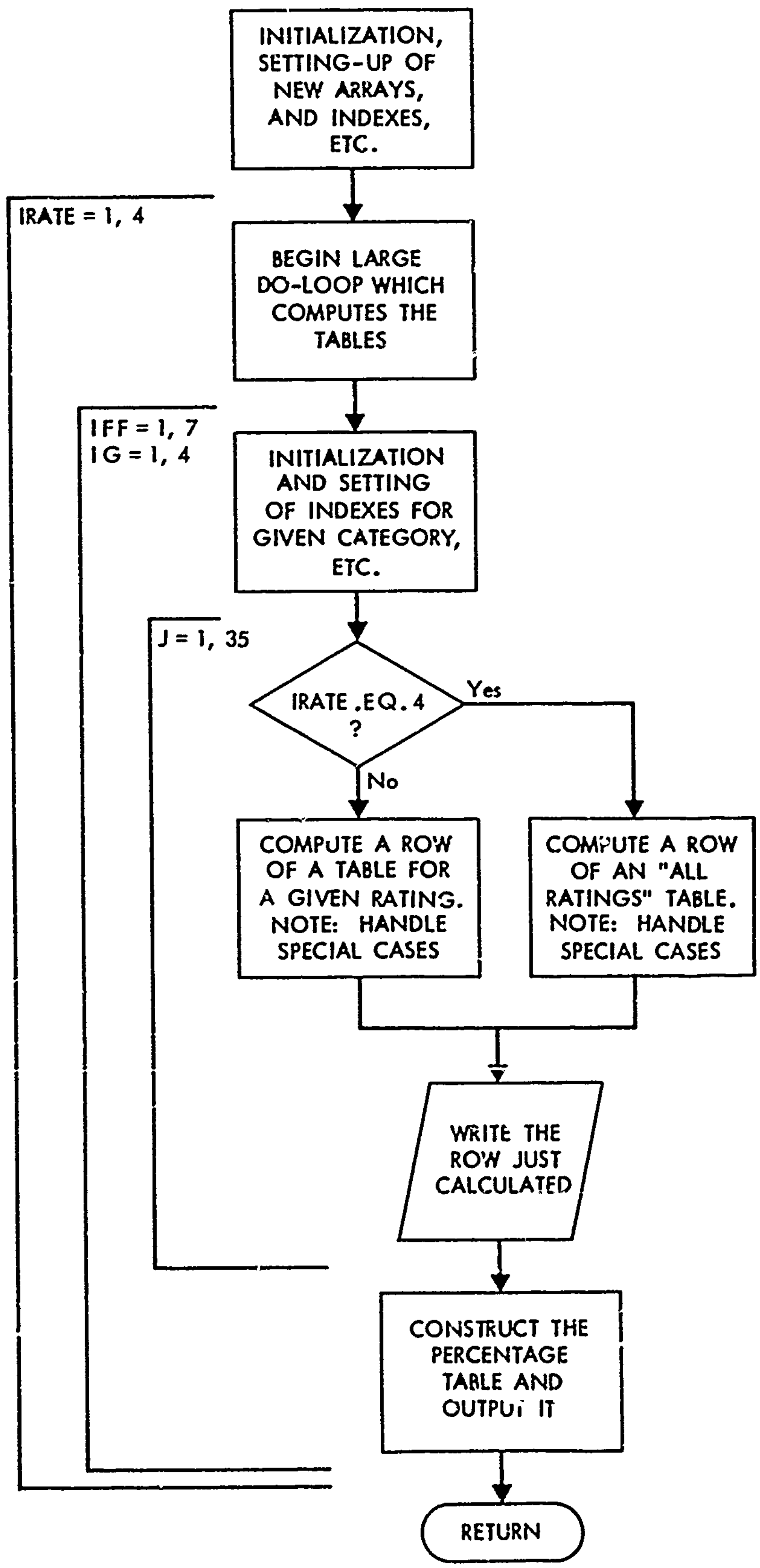


Fig. B-2—Logical flow of tasks in EXTTN routine (career-flow)

Appendix C

PROGRAMMING CONSIDERATIONS

The TOPLINE Static Flow Model was designed for use on an IBM 360/65. It is written in IBM's FORTRAN IV which includes some extensions to American National Standard (ANS) FORTRAN.

TOPLINE is written entirely in double precision (or extended precision) so it may be necessary, depending on the machine being used, to change that. To eliminate double precision, the user should change all the "real" type specification statements. As it is now written, such statements begin "REAL*8." Double precision is eliminated by changing this to "REAL" wherever it appears. It will appear at the beginning of type specification statements or in IMPLICIT statements. These can be found at the beginning of any subroutine, before any executable statement.

Another programming consideration involves the unit numbers of the reader and printer for your installation. These are normally 5, for the reader, and 6, for the printer. The program contains these numbers in the INTEGER variables R (unit number of card reader) and IPR (unit number of printer). To change the values from 5 and 6, respectively, the user will have to reinitialize these variables by changing a card in the deck. It is at the very beginning of the MAIN routine immediately following all COMMON statements. There are comments in the program to help locate it. The card is

```
INTEGER R/5/,IPR/6/
```

You need only change the 5 and 6 to your desired unit numbers.

There is another discrepancy between ANS FORTRAN and IBM FORTRAN that TOPLINE users will have to look out for. In extended FORTRAN it is possible to initialize data in specification statements as is shown in the card image above for R and IPR. This cannot be done in ANS FORTRAN. To eliminate the problem, the above card image could be replaced by

```
INTEGER  R,IPR
DATA  R/5/,IPR/6/
```

or by

```
INTEGER  R,IPR
R = 5
IPR = 6
```

If the variables being initialized are the elements of an array, a DO-loop should be used to initialize them. Data initialization in specification statements has been used only in the MAIN and EXTTN routines.

REFERENCES

1. Department of the Air Force, *The USAF Personnel Plan, Volume One, Personnel Management Objectives*, Washington, D.C., January 1970 (For Official Use Only).

2. Department of the Air Force, *The USAF Personnel Plan, Volume Two, Officer Structure (TOPLINE)*, Washington, D.C., May 1971 (For Official Use Only).

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